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CHARACTERIZATION OF AN ON-SPEC, COMMERCIAL GRADE, JET A AND A NEAR-OFF-SPEC MILITARY F-24; EVALUATION OF +100 THERMAL STABILITY PACKAGE

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Final Report

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AEROSPACE SYSTEMS DIRECTORATE
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UNITED STATES AIR FORCE

NOTICE AND SIGNATURE PAGE

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14. ABSTRACT
This report presents the data and findings for the analysis of two aviation fuels using the fuel system simulator (FSS). One is a commercially sourced Jet A, referred to as Gulf Coast, which meets all criteria in the Jet A specification. The other fuel is an F-24 obtained from Fort McCoy Garrison in Wisconsin. The F-24 fuel, referred to as McCoy, when initially received at Fort McCoy, failed the Jet Fuel Thermal Oxidative Test (JFTOT) breakpoint criteria. The analysis of the fuels using the FSS showed the Gulf Coast fuel to be representative of a quality aviation fuel. It exhibited low- to no-thermal stability issues; low- to no-coke deposition within the fuel lines of the FSS; and low- to no-hysteresis on the critical valves within the fuel system. In stark contrast, the results obtained for the McCoy fuel showed extreme thermal stability problems–high coke deposition within the fuel lines of the FSS and moderate to severe hysteresis on the critical valves within the fuel system.

15. SUBJECT TERMS
Jet A, F-24, thermal stability, +100, Ft McCoy fuel, Gulf Coast fuel, fuel system simulator

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Table of Contents

List of Figures

List of Tables

Table No. **Page**

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Barbara Miller (UDRI)

List of Acronyms and Terms

ACRONYM or TERM	DESCRIPTION
+100	Spec Aide 8Q462 Thermal Stability Improving Additive
BFA	Burner Feed Arm
BT	Body Tank
CT	Conditioning Tank
EHSV	Electro-Hydraulic Servo Valve
F-24	NATO designation for Jet A with Military Additives
FCOC	Fuel-Cooled Oil Cooler
FDV	Flow Divider Valve or Flow Diverter Valve
FSS	Fuel System Simulator
GC	Gulf Coast
Jet A	Commercial aviation turbine fuel
JFTOT	Jet Fuel Thermal Oxidation Test, ASTM-D3241
MC	McCoy
MDA	Metal Deactivator Additive
Neat	Without additives
SV	Servo Valve
WT	Wing Tank

1.0 EXECUTIVE SUMMARY

Recent anecdotal reports within the fuels user community have indicated a potential increase in thermal stability issues with Jet A and F-24. The nature of the problem is unclear, with reports citing transient behaviors, inconsistent results and time dependent properties. The apparent high level of concern within the user community warranted an investigation of the impact of current aviation fuel thermal margin and performance on Air Force fleet operations. To perform that study, we utilized the Fuels System Simulator (FSS), a 1/72 scale rig that replicates the components of an aircraft fuel system, aircraft heat loads, allows for fuel recirculation, and supports mission simulations.

This report presents the data and findings for the analysis of two aviation fuels using the FSS. One is a commercially-sourced Jet A, referred to as "Gulf Coast" (GC), which meets all criteria in the Jet A specification. The other fuel is an F-24 obtained from Fort McCoy Garrison in Wisconsin. The F-24 fuel, referred to as "McCoy" (MC), when initially received at Fort McCoy failed the JFTOT breakpoint criteria (breakpoint must be $\geq 260\ ^{\circ}C$). Upon receipt at our facilities, McCoy was found to be fully in specification, including a JFTOT breakpoint value of $265\ ^{\circ}C$. The transient or time-dependent nature of the failing thermal stability criteria identifies the McCoy fuel as a likely example of the current fuel issues reported by the fuels user community.

The analysis of the fuels using the FSS showed the Gulf Coast fuel to be representative of a quality aviation fuel. It exhibited low to no thermal stability issues; low to no coke deposition within the fuel lines of the FSS, and low to no hysteresis on the critical valves within the fuel system. In stark contrast, the results obtained for the McCoy fuel showed extreme thermal stability problems; high coke deposition within the fuel lines of the FSS, and moderate to severe hysteresis on the critical valves within the fuel system.

Additional analysis of the McCoy fuel using the thermal stability improver +100 additive package Spec Aid 8Q462 shows complete alleviation of the thermal stability issues (Figure 1). The plot shows the temperature of the burner feed arm (BFA) vs. the experimental run time. Increases in BFA temperature correlate with coke deposition within the BFA; coke values for McCoy = 81 mg, McCoy+100 = 0.4 mg, Gulf Coast = 3 mg as determined by LECO Carbon Analyzer The McCoy fuel additized with +100 performs similar to the Gulf Coast fuel and conforms to a quality aviation fuel.

Additional analysis of the McCoy fuel using a commercial additive for metal deactivation (MDA) showed only marginal improvement over un-additized McCoy fuel. The results indicated moderate thermal stability issues; moderate coke deposition in the FSS fuel lines, and low to moderate hysteresis on the critical valves within the fuel system.

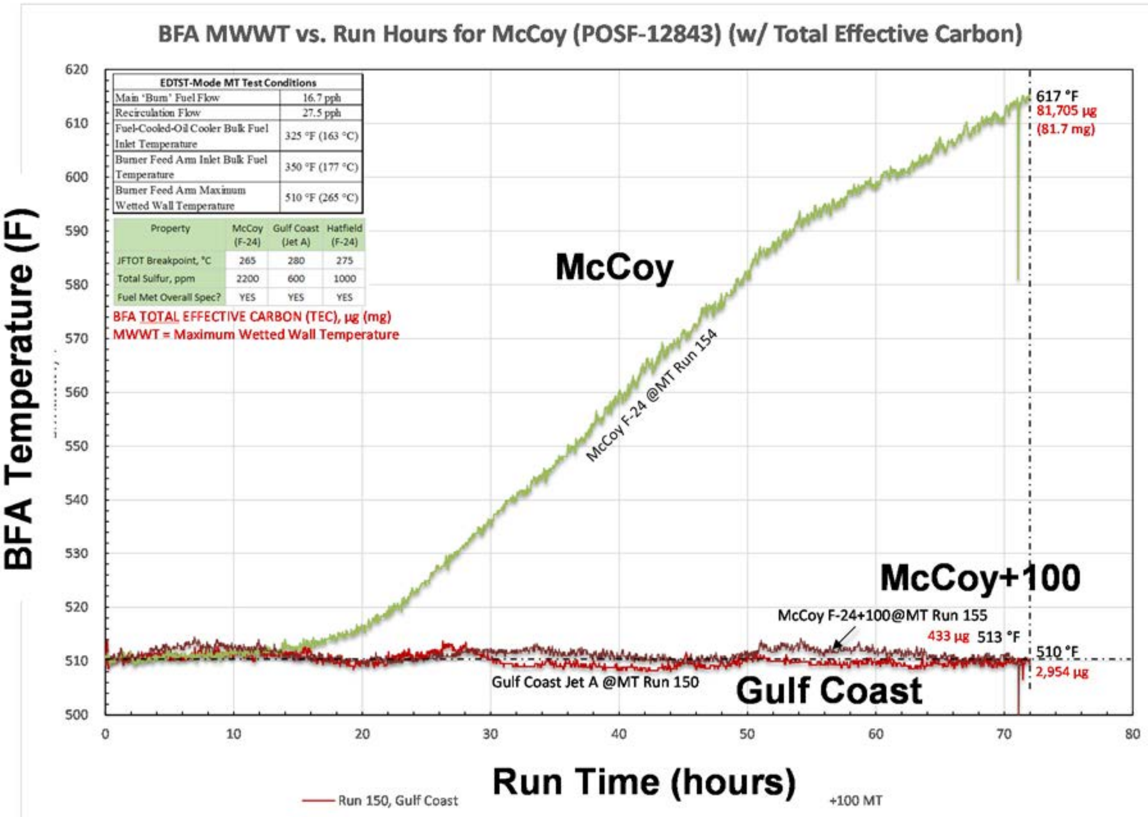

Figure 1. FSS analysis of the McCoy fuel, the McCoy fuel with +100 additive, and the Gulf Coast fuel under MT conditions (see Experimental Section)

2.0 INTRODUCTION

Aviation turbine fuel is a complex mixture of hundreds to thousands of hydrocarbon-based compounds. The exact make-up and number of these compounds varies from fuel to fuel. This variance can be due to many parameters, including but not limited to, the source feed stocks and the refining process. With the use of non-petroleum-derived feedstocks (such as bio-based synthetic fuels, feedstocks from tar sands, shale oil, etc.), the exact chemical makeup of fuels can vary even more than in the past.

Jet fuels are identified and segregated by property specifications; of greatest interest here are Jet A (ASTM D1655) and F-24 (ASTM D1655 + SDA, CI/LI, FSII). These are the current, required baselines for military aviation fuels. The specifications dictate property levels or ranges that must be achieved in order to be utilized as the stated fuel.

Over the past two years, the fuel users' community has witnessed an apparent increase in fuel thermal stability problems. These reports have been shared informally through various conference and meeting venues. The indicator of a thermal stability problem has been a failed Jet Fuel Thermal Oxidative Test (JFTOT) reading; acceptable JFTOT values are anything ≥ 260 °C. Because the fuels were procured as in-specification, the failed JFTOT reading indicates something occurring in transport since they are typically observed upon receipt at point-of-use facilities.

Recently, AFRL/RQTF with the assistance of the Defense Logistics Agency (DLA), was able to acquire approximately 5000 gals of a failed F-24 from Fort McCoy Army base in Fort McCoy WI (referred to as 'McCoy' fuel). Data shows that the JFTOT reading initially passed at the refinery, and ultimately failed at Fort McCoy (JFTOT < 260 °C). Upon receipt at our facility, the JFTOT reading was found to be passing with a value of 265 °C. All other properties as measured by the Air Force Petroleum Office (AFPO) were within specification for F-24 (see Appendix B, Figures B1 and B-2). The fuel was termed 'marginal' as it just passes the JFTOT thermal stability criteria and has a demonstrated history of property variance.

Utilizing the AFRL/RQTF fuel system simulator (FSS), we probe the effects of a marginal fuel on general fuel system performance. For comparison, a second fuel termed 'Gulf Coast' was analyzed concurrent with the McCoy fuel. The Gulf Coast fuel was a commercially sourced Jet A that met all specification requirements when analyzed by AFPO (see Appendix A, Figures A-2 and A-3). The studies included the neat fuels and their impact on valve hysteresis (flow diverter and servo valves), coke deposition (witness screens and burner feed arm), and FSS operation at three different steady-state temperature settings targeting legacy, next-generation, and future operational conditions. Also investigated under the same set of conditions was the effect of the +100 additive package, and the metal deactivator (MDA) package.

3.0 EXPERIMENTAL

3.1 Materials

Gulf Coast fuel (POSF-12831, an internal tracking number) was a low-sulfur (0.06 wt%) Jet A meeting ASTM D1655 specification requirements. 4600 gallons of this fuel was acquired in July 2016 via Ascent Aviation Group, a subsidiary of World Fuel Services, Inc. It was refined in a facility on the Gulf Coast and then transported (transport method unknown) to the Marathon Ashland Petroleum terminal in Louisville, KY (TTR Louisville, KY, Tank 157). From there it was loaded onto a truck and transported to WPAFB and off-loaded into a 6,000-gallon tank in the S-Farm facility. JFTOT breakpoint analysis was conducted on this fuel in its neat form twice; on receipt in July 2016 and as a status check in November 2016. Both analyses yielded a value of 290 °C. A full specification test was performed upon receipt and is reported In Appendix A. All values were within specification.

The McCoy fuel (POSF-12843) was a high-sulfur (2200 ppm) Jet A refined in northwest Ohio and additized to F-24 specifications. Upon arrival at Ft McCoy Garrison, the fuel failed to meet the thermal stability specification, having a JFTOT breakpoint of lower than 260 °C. 5000 gallons of this failed specification fuel was obtained by AFRL for testing and evaluation. JFTOT breakpoint analysis was conducted on this fuel in its neat form four times; upon receipt in July 2016, as a status check in Aug. 2016, and again in Oct. 2016 from two separate storage tanks. The initial value for JFTOT breakpoint obtained in July indicated a passing value; 265 °C, the status check in Aug. indicated a lower value of 260 °C, and the last check of the two separate tanks indicated one as failing (250 ºC) and the other as passing (260 ºC). A full specification test was performed on receipt and is reported in Appendix B. All values were within specification.

3.2 The Fuel System Simulator (FSS)

Figure A-4 shows a basic block diagram of the key FSS components. A more detailed description of the FSS, its components, and its method of operation is provided in Appendix C. Briefly, the FSS is a small-scale simulator (1/72nd scale) of an advanced fighter aircraft's fuel system. The FSS consists of three major subsystems; conditioning, airframe, and engine subsystem. These subsystems work together to form a complete aircraft fuel system simulation. The conditioning subsystem pre-conditions fuel prior to a simulation test (sets initial bulk fuel temperatures). The airframe subsystem simulates all of the heat loads from the airframe fuel system components and functions, including effects from altitude. The engine subsystem simulates the heat loads from all of the engine fuel system components and functions. Three critical heat transfer components are identified with these subsystems; airframe heat exchanger (AFHX), fuel-cooled oil cooler (FCOC), and burner feed arm (BFA).

In the collection of data the FSS is operated in steady state mode at one of three preset conditions, as shown in Table 1.

Table 1. FSS Run Conditions

EDTST MODE RUN CONDITIONS			
Run Parameter	LT Conditions	MT Conditions	HT Conditions
Main Burn Flow, PPH	16.7	16.7	16.7
Recirculation Flow, PPH	27.5	27.5	27.5
Airframe HX Bulk Fuel Out	285 °F (140 °C)	285 °F (140 °C)	285 °F (140 °C)
FCOC Bulk Fuel Inlet Temperature	300 °F (149 °C)	325 °F (163 °C)	325 °F (163 °C)
FCOC Bulk Fuel Outlet Temperature/BFA Bulk Fuel Inlet Temperature	325 °F (163 °C)	350 °F (177 °C)	375 °F (190 °C)
BFA Max Wetted Wall	510 °F (265 °C)	510 °F (265 °C)	510 °F (265 °C)

Flow rates are maintained at constant values of 16.7 PPH (main core flow) and 27.5 PPH (recirculation flow). To establish a condition (LT, MT, or HT), power levels for the heaters associated with the heat exchangers are adjusted so as to obtain the bulk fuel temperature indicated. Once set, the system then runs continuous for 72 hours. Changes in temperatures from initial settings are usually indicative of carbon deposition and are recorded as analytical data (BFA temperature profiles). Additional data is obtained at the completion of the test in the form of carbon accumulation values for the BFA (by LECO Carbon Analyzer, Model RC612), servo and flow diverter valve hysteresis, photographic imaging of valve surfaces and witness screens, as well as SEM/EDX analyses for coke deposition morphology.

The Gulf Coast and McCoy fuels were run multiple times under various conditions. The ordering of the runs was arranged so as to ensure no impact from fuel carry over or FSS contamination. The sequence of runs is shown in Figure 3, along with indication of any analytical or specification testing. In addition to FSS data, the individual fuels were analyzed by GCxGC (Agilent 78904A) and Quartz Crystal Microbalance (QCM). The data for these analyses are provided in Appendices F through R.

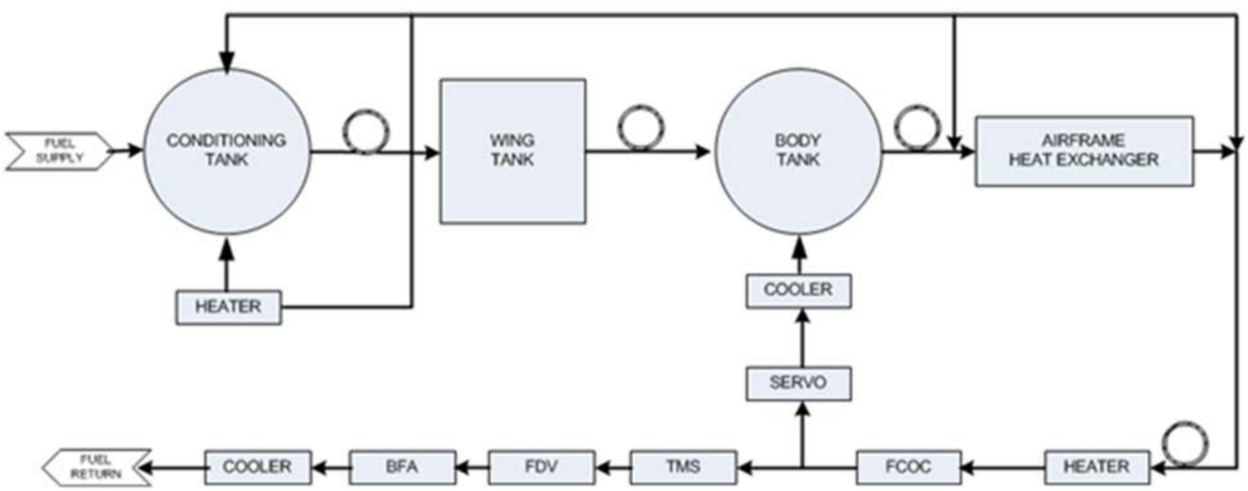

Figure 2. Basic Block Flow Diagram of the FSS

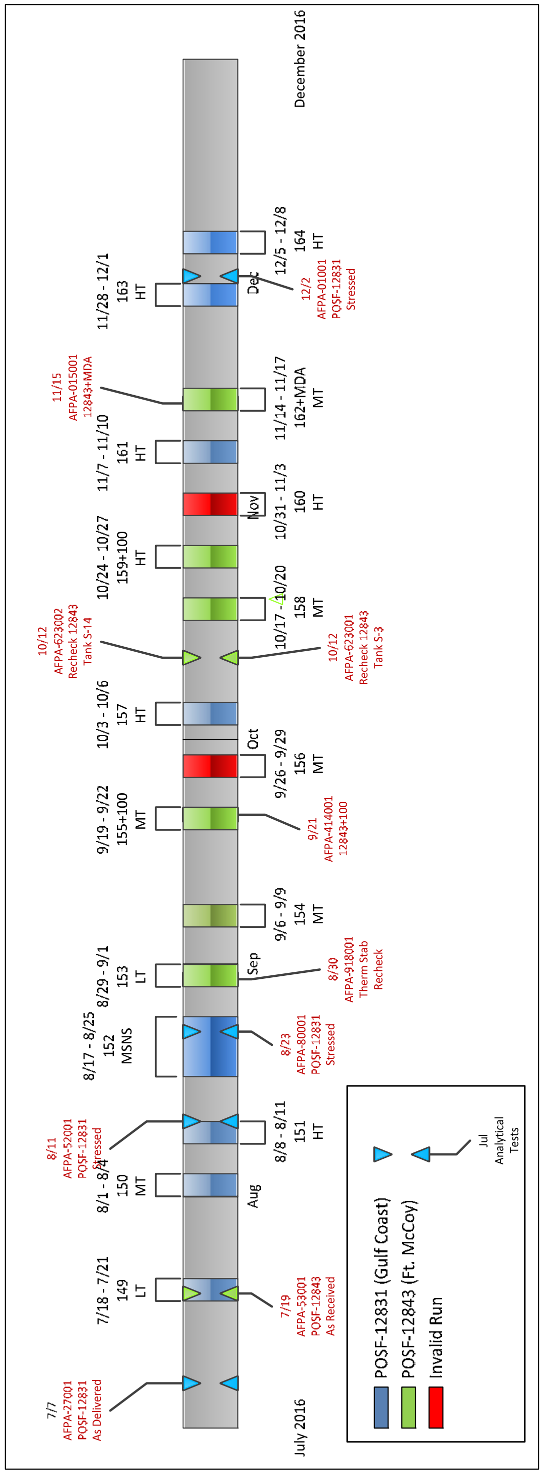

Figure 3 FSS Runs and Analytical Testing Timeline

4.0 RESULTS AND DISCUSSION

Figure 4 shows the data obtained for the McCoy and Gulf Coast fuels analyzed using the FSS under LT conditions. The plot shows the BFA temperature profile over the full 72 hour analysis. The temperature trace for the Gulf Coast fuel represents desired performance, showing little to no temperature rise throughout the run. The temperature trace for the McCoy fuel shows a small but measurable increase in BFA maximum wetted wall temperature by the end of the run. The increase is known to result from the insulating effect coke deposition causes within the tube representing the BFA. Table 2[1] provides the post-analysis coke deposition (Total Effective Carbon)values for each of the runs; showing a low value of 3053µg for the Gulf Cost LT run, and a higher value of 9366 µg for the McCoy fuel under the same conditions. The BFA temperature values and the coke deposition numbers, when compared to past FSS analyses, are sufficiently elevated so as to be classified as a potentially poor performing fuel.

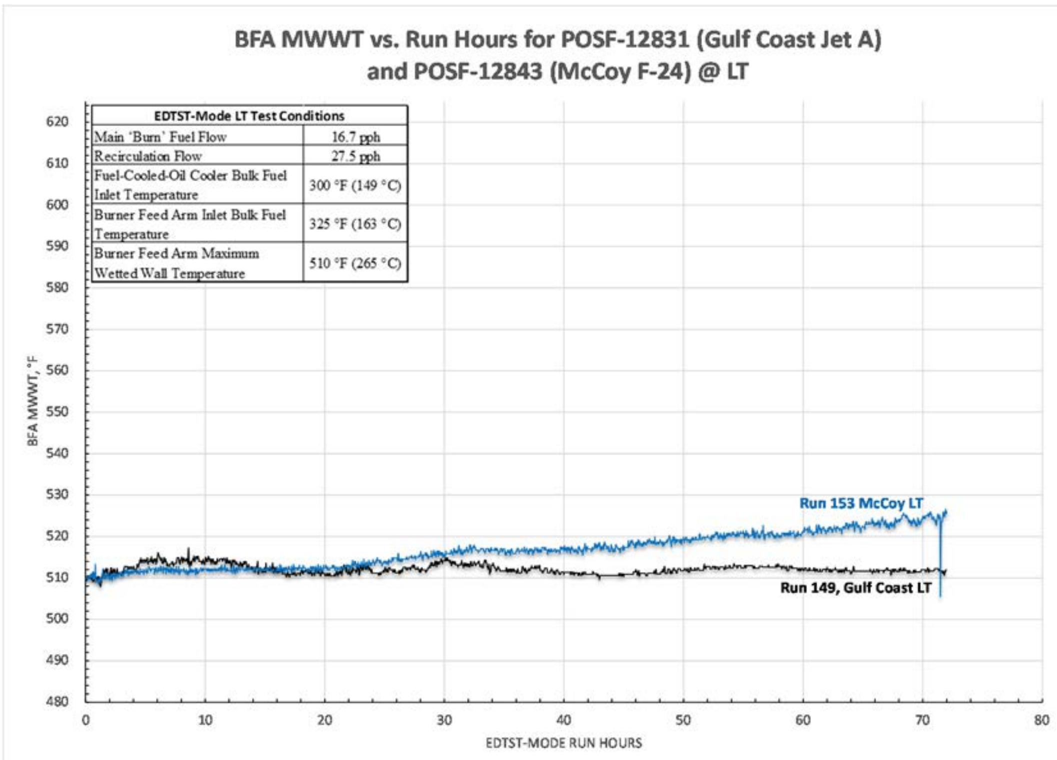

Figure 4. BFA MWWT vs. Run Hours for Gulf Coast and McCoy Fuels at LT Conditions

Figure 5 shows similar data to Figure 4, but under MT conditions. Again, the Gulf Coast fuel indicates a desired result, yielding little to no temperature rise in the BFA maximum wetted wall temperature, even at the higher temperatures probed at MT. The McCoy fuel in contrast, demonstrates a significant increase in BFA maximum wetted wall temperature. The McCoy fuel was analyzed twice under MT conditions (Run 154 and Run 158). Run 154 maximum wetted wall temperature rise was more than double that of Run 158 (105 °F for Run 154 and 41 °F for Run 158). The observed temperature increases for the McCoy fuel under Run 154 MT conditions represent a historical maximum for FSS operation. The temperature rise and the accompanying coke values (Table 2) are indicative of a fuel with potential to disrupt system operations. The fact that the reproducibility of the McCoy data under MT conditions is suspect may be

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[1] *Table 2 shows a comparison of all carbon deposition data for all deposition-monitoring components for all Runs discussed in this report.*

attributed to the system being outside its normal operational, calibrated regime with respect to the level of coke deposited in the BFA (non-linear response for extreme coke levels).

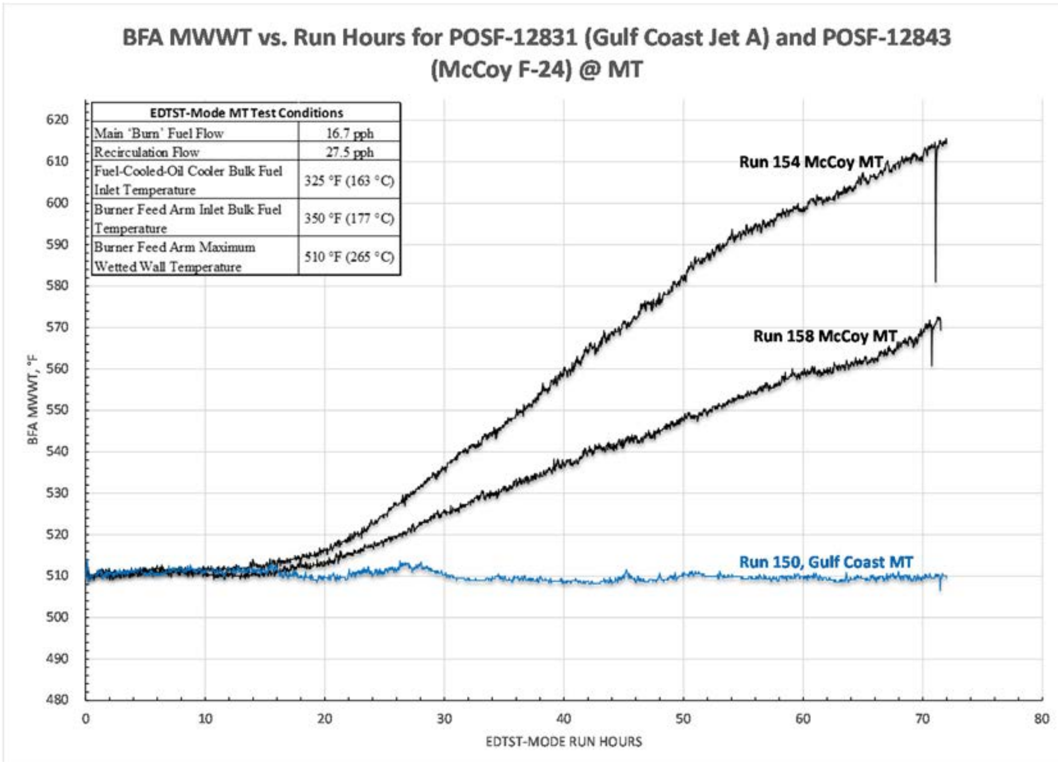

Figure 5. BFA MWWT vs. Run Hours for Gulf Coast and McCoy Fuels at MT Conditions

Table 2. Fuel Data Summary for Gulf Coast (POSF-12831) and McCoy (POSF-12843) Fuels

Gulf Coast (POSF-12831) and McCoy (POSF-12843) Fuels Data Summary								
Fuel & Condition	**BFA ΔMWWT °F**	**BFA Total Effective Carbon, µg**	**FDV Hysteresis Area[1]**	**SV Hyseresis Area[1]**	**F303 Deposition µg**	**F304 Deposition µg**	**TMS Deposition µg**	**F702 Deposition µg**
Gulf Coast								
LT								
Run 149	0	3053	4	77	77	25	8.4	42
MT								
Run 150	0	2954	-8	69	70	48	13	572
HT								
Run 151	-1	5077	79	619	107	78	30.6	1617
Run 157	-9	3708	232	871	146	2986	240	2999
Run 163	-19	12433	305	769	282	170	246	2598
Run 164	-6	6748	68	714	171	130	38	1854
McCoy								
LT								
Run 153	14	9366	71	-113	98	63	27	135
MT								
Run 154	105	81705	212	1847	125	222	90	151
Run 158	43	40973	1	2057	129	177	53	363
McCoy +100								
MT								
Run 155	0	433	2	203	13.2	26.8	8.7	268
HT								
Run 159	4.2	2453	39	80	23.1	40.8	18.1	109
McCoy +MDA								
MT								
Run 162	29	7851	59	227	82	63	25	68

NOTES:

[1] *FDV and SV Hysteresis Area: Change in Integrated Area Between Pre-test and Post-test Curves Sets*

F303: HP Pump Inlet (AFXH Out)

F304: FCOC Inlet (HPHX Out)

TMS: Downstream of F305 prior to FDV/BFA

F702: Recirc Flow Path

CONDITIONS: (AFHX Out/HPHHX OUT/FCOC OUT/BFA MWWT)

LT: 285°F/300°F/325°F/510°F **MT:** 285°F/325°F/350°F/510°F **HT:** 285°F/325°F/375°F/510°F

Because of the very high levels of coke generated for the McCoy fuel under MT conditions, it was decided that no analysis of the McCoy fuel under HT conditions would be performed. Instead, the fuel was prepared with the Spec Aid 8Q462 additive package (+100) for operation under MT and HT conditions. The use of the +100 thermal stability package traditionally provides increased thermal margin and an ability to mitigate coke deposition within a vehicle fuel system. Figure 6 shows the data obtained for the McCoy fuel when additized with +100 and analyzed with the FSS under MT and HT conditions. Remarkably, the temperature data trace shows little to no increase in BFA maximum temperature over the entire 72 hour analysis for either MT or HT conditions. The lack of temperature rise is supported by the

post-analysis coke deposition values (Table 2) which indicate little to no coke was accumulated within the BFA. These results appear to indicate that the McCoy fuel, termed marginal and shown to be a poor performing (LT) to potentially system disrupting (MT) fuel, can be made to display quality fuel performance with the addition of the +100 thermal stability package.

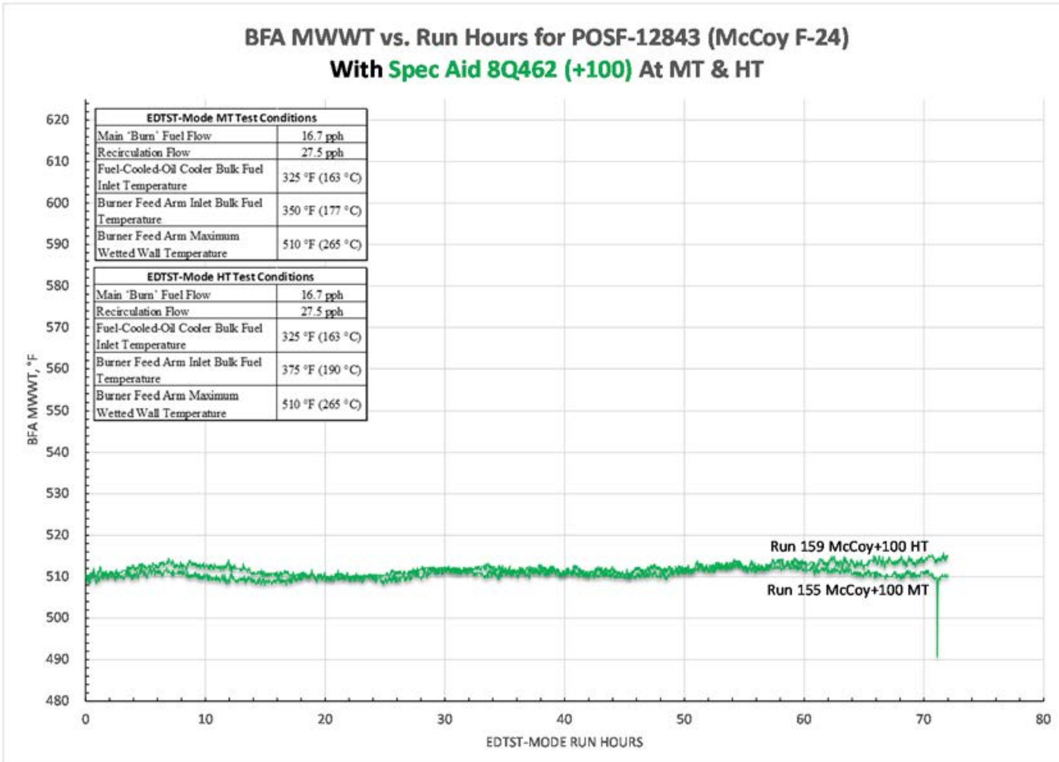

Figure 6. BFA MWWT vs. Run Hours for McCoy Fuel at MT and HT Conditions With SpecAid 8Q462 (+100) Additive at 256 mg/L

As a matter of community interest, the McCoy fuel was also analyzed using the MDA additive package. The use of MDA is not authorized within the F-24 specification; however, commercial entities have utilized it to minimize the effects of other marginal fuels. The main reported effect is to raise the JFTOT value such that a non-passing fuel can become a passing fuel. The effect of MDA on the behavior of the McCoy fuel was analyzed under MT conditions and compared to the quality response of the Gulf Coast fuel (reference Figure 5). The BFA temperature profiles are provided in Figure 7, and show relatively high BFA temperature values and post analysis coke deposition values for the McCoy MDA. The results appear to indicate that MDA has little impact on the amount of coke deposition observed within the fuel system. It is therefore possible that MDA improves the result of a JFTOT analysis following a different mechanism than that observed in the FSS where no clear impact was observed.

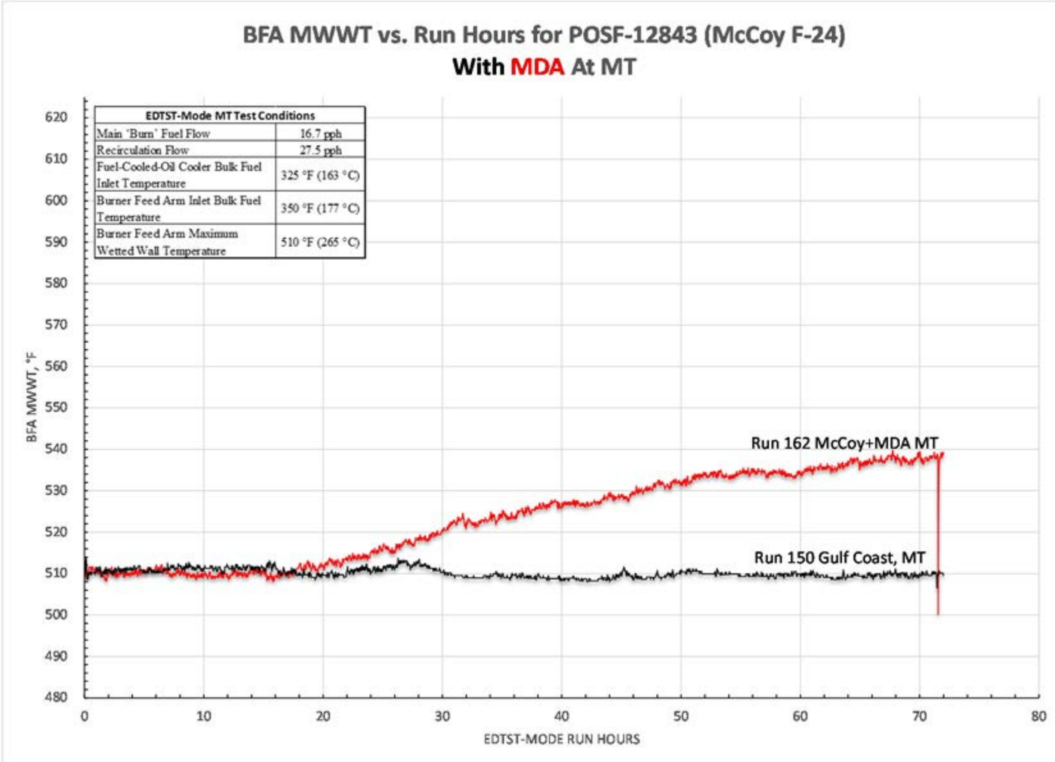

Figure 7. BFA MWWT vs. Run Hours for McCoy Fuel at MT Conditions with MDA

While BFA temperature profile data and the correlating coke deposition values serve as strong indicators of fuel performance, it is the operation of the flow diverter (FDV) and servo (SV) valves that provide the best indicator of potential system difficulties for an actual high-performance aircraft. Valve performance is measured by recording and comparing hysteresis responses prior to and after the 72 hour analysis. Figure 8 and Figure 9 show typical FDV hysteresis plots for both low-depositing (McCoy+100 MT) and high-depositing (McCoy MT) fuels, showing flow through the valve vs. differential pressure across the valve. Similarly, Figure 10 and Figure 11 show typical Servo Valve hysteresis plots for a low-depositing (McCoy+100 MT) and high-depositing (McCoy MT) fuels.

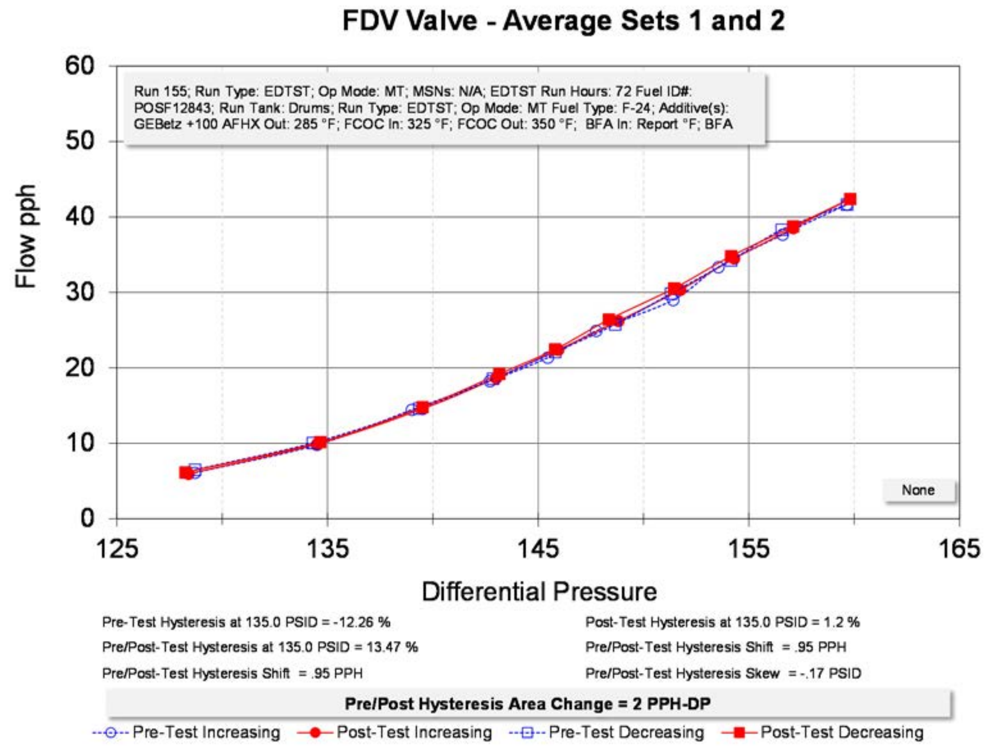

Figure 8. Typical FDV Hysteresis Curve for a Low-Depositing (McCoy +100 MT) Fuel

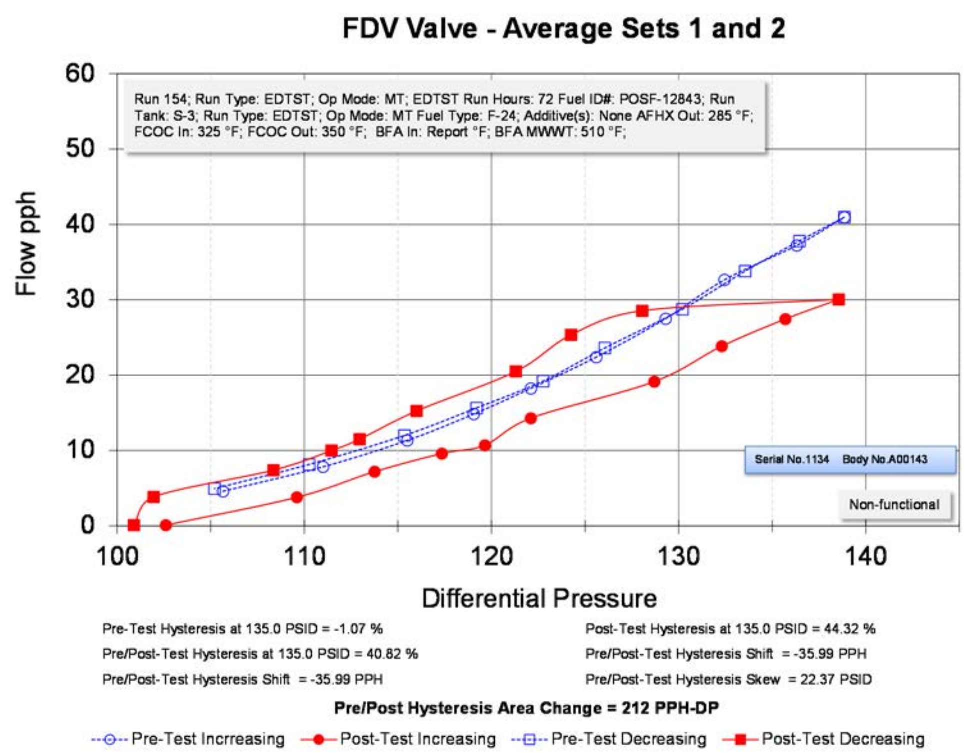

Figure 9. Typical FDV Hysteresis for a High-Depositing (McCoy MT) Fuel

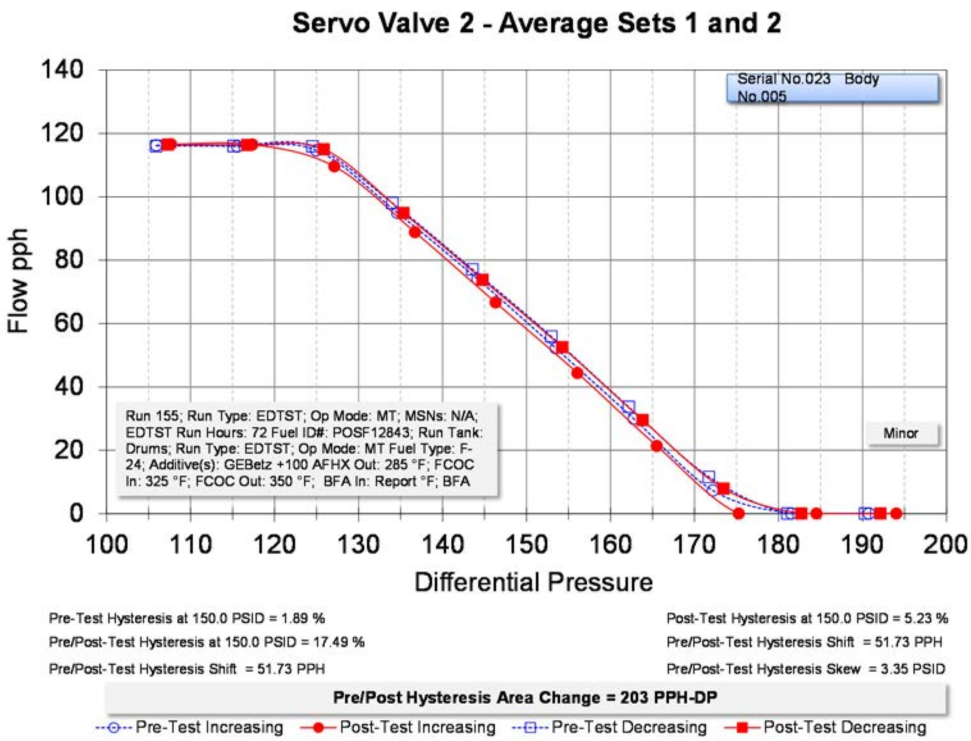

Figure 10. Typical Servo Valve Hysteresis for a Low-Depositing (McCoy+100 MT) Fuel

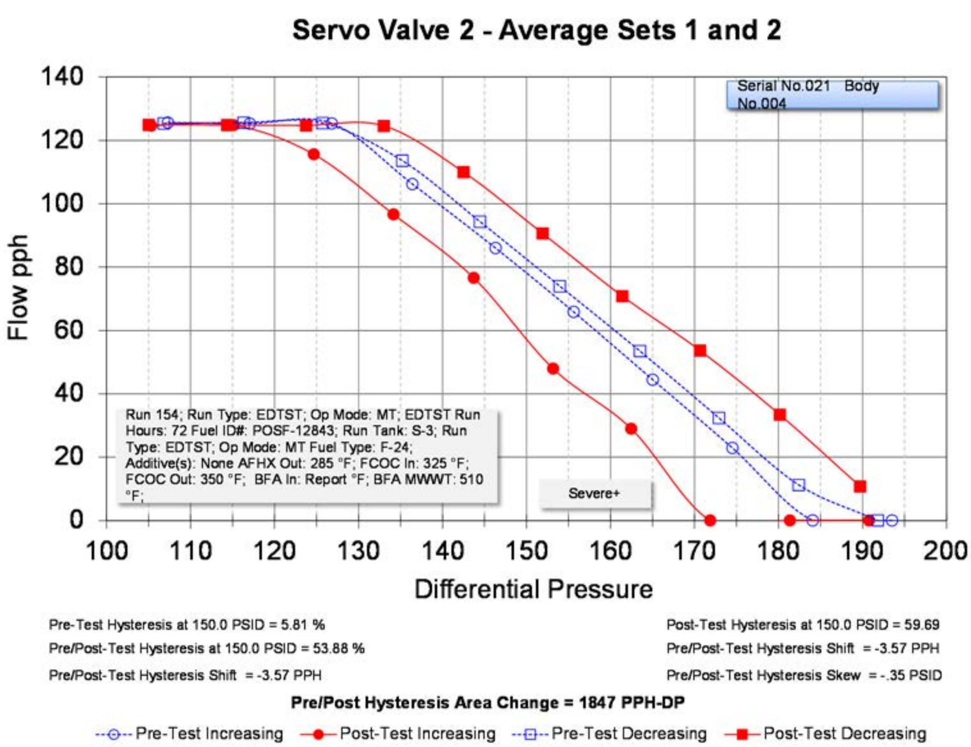

Figure 11. Typical Servo Valve Hysteresis for a High-Depositing (McCoy MT) Fuel

In an effort to convert these hysteresis plots to a quantifiable and easy to analyze metric, we integrate the areas between the lines for both pre- and post-test plots. The absolute value difference between these areas is then a single-value measure of differential hysteresis (Table 2). The hysteresis values have the units of pounds per hour differential pressure (PPH-DP). For the FDV, high numbers (> ~200) indicate increased FDV hysteresis which may translate to poorer valve performance and higher risk for the engine/aircraft. Similarly, for the Servo Valve, high numbers (> ~500) indicate increased Servo Valve hysteresis which may translate to poorer valve performance and higher risk for the engine/aircraft. The Gulf Coast HT, McCoy MT (and HT by inference), and the McCoy MDA all demonstrate valve hysteresis values that indicate risk to engine/aircraft operation. The addition of the +100 thermal stability additive package alters the response of the McCoy fuel such that both MT and HT conditions demonstrate acceptable valve hysteresis performance.

5.0 CONCLUSION

The analysis of the fuels using the FSS showed the Gulf Coast fuel to be representative of a quality aviation fuel. It exhibited low to no thermal stability issues; low to no coke deposition within the fuel lines of the FSS, and low to no hysteresis on the critical valves within the fuel system (Table 2). In stark contrast, the results obtained for the McCoy fuel showed extreme thermal stability problems; high coke deposition within the fuel lines of the FSS, and moderate to severe hysteresis on the critical valves within the fuel system.

Additional analysis of the McCoy fuel using the thermal stability improver +100 additive package shows complete alleviation of the thermal stability issues. The McCoy fuel additized with +100 performs similar to the Gulf Coast fuel and conforms to a quality aviation fuel.

Additional analysis of the McCoy fuel using a commercial additive for metal deactivation (MDA) showed only marginal improvement over un-additized McCoy fuel. The results indicated moderate thermal stability issues; moderate coke deposition in the FSS fuel lines, and low to moderate hysteresis on the critical valves within the fuel system.

General References

1) "Metal Deactivator Additive (MDA) Impacts on Thermal Stability", George R. Wilson, III, CRC Report AV-6-06, June 2010
2) Coordinating Research Council website, https://crcao.org/drop_files/AV-24-16%20Survey/AV-24-16surveyhtmlpage!.html; 22 June 2017

APPENDIX A
Fuel Analysis Compilation – POSF-12831, Gulf Coast Fuel

Marathon Petroleum Company LLC

Certificate of Analysis

Catlettsburg Refining Division

P.O. Box 1492
Catlettsburg, KY 41129
Phone No: (606) 921-3333
Fax No: (606) 921-6565
Date: 6/14/2016 10:29:09 AM

Product: Jet Fuel
Grade: JET-A

Sample Description:	TTR Louisville Tank 157	**Sample Date:**	6/13/2016 11:00:00 AM
Tank:	ZLOUST0157	**Date Analyses Completed:**	6/14/2016 10:01:33 AM
Batch Number:	JF16444335	**LIMS ID:**	444335
Batch Size:		**Vessel/Pipeline:**	157 Tank
Date Loaded:		**Quantity GAL:**	

Comments: Conductivity additive has not been added to this fuel.

Test Method	Property	Result	Units	Lower Limit	Upper Limit
D1655	Meets Jet-A, latest revision	Pass			Pass
Workmanship					
D4176	Appearance	Clear and Bright			Clear & Bright
D5452	Particulates	0.11	mg/L		1.00
Physical Properties					
D4052	API Gravity	41.7	°API@60°F	37.0	51.0
D130	Copper Strip Corrosion - 2 hr @ 100°C	1B			1B
D3241	JFTOT - P@260°C	0.0	mm Hg		25.0
D3241	Tube Deposit Rating	1			<3
D3241	Heater Tube Deposite Description	Normal			Normal
D3948	Microseparometer Rating Mode A	97		85	
D6045	Saybolt Color	19		10	
D56	Tag Flash Point	125	°F	100	
D2624	Conductivity*	5			
D2276	Munsell Color, Dry	B-1			
D381/IP540	Existent Gum	1	mg/100 mL		7
Chemical Analyses					
D2622	Sulfur	561.4	wt. ppm		3,000.0
D4952	Doctor Test	Doctor Positive			Doctor Negative
D3227	Mercaptan Sulfur (if Doctor positive)	13	wt. ppm		30
D3242	Acidity	0.002	mg KOH/g		0.100
D1840	Napthalenes (if required)	0.00	vol. %		3.00
D7797	FAME	<20	ppm wt		50
Distillation					
D86	IBP, % Recovered	309.2	°F		
D86	10%	379.3	°F		401.0
D86	50%	430.1	°F		
D86	90%	485.2	°F		550.0
D86	FBP	523.8	°F		572.0
D86	Loss	0.5	vol. %		1.5
D86	Residue	1.5	vol. %		1.5
Cold Flow Properties					
D445	Viscosity @ -4°F (-20°C)	6.093	cSt	0.000	8.000
D5972	Freeze Point	-47.3	°C		-40.0
Combustion					
D3338	Net Heat of Combustion	18570	BTU/lb	18,400	
D1322	Smoke Point	23.0	mm	25.0	
D1319	Aromatics	15.7	vol. %		25.0

[1] When conductivity additive is used, it must be noted.

Batch(es): JF16444335/335

Reviewed By:
Charles Whitehead
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REFINING-RAD-ASPHALT CERTIFICATION
606+921-2827

COA Prepared By:
Kevin R Riddle
TECHNICIAN LABORATORY SR
REFINING-RAD-JET FUEL CERTIFICATION
606-921-6278

Figure A - 1 POSF-12831 Certificate of Analysis

AFPET LABORATORY REPORT
AFPA/PTPLA
2430 C Street
Building 70, Area B
Wright-Patterson AFB, OH 45433-7632

Lab Report No:2016LA58527001   Date Received:07/07/16 1249 hrs*   Date Sampled: **
Cust Sample No:12831   Date Reported:07/20/16 1427 hrs*   Protocol:FU-AVI-0036
JON: GENERAL FUND

Sample Submitter:
AFRL/RQTF
1790 Loop Road N
Bldg 490
Wright-Patterson AFB, OH 45433

Reason for Submission: AFRL Research
Product: Aviation Turbine Fuel, Kerosene
Specification: ASTM D 1655 - 15de1 Grade:Jet A

Qty Submitted: 3 gal

Method	Test	Min	Max	Result	Fail
MIL-STD-3004D	Appearance			Pass	
ASTM D 3242 - 11	Total Acid Number (mg KOH/g)		0.10	0.003	
ASTM D 1319 - 15	Aromatics (% vol)		25	17.4	
ASTM D 3227 - 13	Mercaptan Sulfur (% mass)		0.003	0.001	
ASTM D 4294 - 16e1	Total Sulfur (% mass)		0.30	0.06	
ASTM D 86 - 15	Distillation				
	10% Recovered (°C)		205	193	
	20% Recovered (°C)		Report Only	203	
	50% Recovered (°C)		Report Only	221	
	90% Recovered (°C)		Report Only	251	
	End Point (°C)		300	272	
	Residue (% vol)		1.5	1.3	
	Loss (% vol)		1.5	0.8	
ASTM D 93 - 16	Flash Point (°C)	38		54	
ASTM D 4052 - 15	Density @ 15°C (kg/m³)	775	840	815	
ASTM D 5972 - 16	Freezing Point (°C)		-40	-46	
ASTM D 445 - 15a	Viscosity @ -20°C (mm²/s)		8.0	6.3	
ASTM D 1322 - 15	Smoke Point (mm)	25		25	
ASTM D 130 - 12	Copper Strip Corrosion (2 h @ 100°C)		1 (Max)	1a	
ASTM D 3241 - 16	Thermal Stability @ 275°C				
	Tube Deposit Rating, Visual			1	
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			12	
ASTM D 3241 - 16	Thermal Stability @ 295°C				
	Tube Deposit Rating, Visual			<4A	X
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			144	
ASTM D 3241 - 16	Thermal Stability @ 300°C				
	Tube Deposit Rating, Visual			4A	X
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			227	
ASTM D 381 - 12	Existent Gum (mg/100 mL)		7	4	
ASTM D 1094 - 07 (2013)	Water Reaction Interface Rating		1b (Max)	1	
ASTM D 7224 - 14	MSEP	70		89	
ASTM D 5006 - 11 (2016)	FSII (% vol)		Report Only	0.00	

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Figure A - 2 As Delivered Specification Analysis Results (AFPA) – Page 1 of 2

AFPET LABORATORY REPORT
AFPA/PTPLA
2430 C Street
Building 70, Area B
Wright-Patterson AFB, OH 45433-7632

Lab Report No:2016LA58527001	Date Received:07/07/16 1249 hrs*	Date Sampled: **
Cust Sample No:12831	Date Reported:07/20/16 1427 hrs*	Protocol:FU-AVI-0036
JON: GENERAL FUND		

Sample Submitter:
AFRL/RQTF
1790 Loop Road N
Bldg 490
Wright-Patterson AFB, OH 45433

Reason for Submission: AFRL Research
Product: Aviation Turbine Fuel, Kerosene
Specification: ASTM D 1655 - 15de1 Grade:Jet A

Qty Submitted: 3 gal

Method	Test	Min	Max	Result	Fail
ASTM D 2624 - 15	Conductivity (pS/m)	50	600	0	X
ASTM D 5001 - 10 (2014)	Lubricity Test (BOCLE) Wear Scar (mm)	Report Only		0.62	
MIL-DTL-83133J	Filtration Time (min)			4	
ASTM D 7171 - 05 (2016)	Hydrogen Content by NMR (% mass)			13.9	
ASTM D 4809 - 13	Net Heat of Combustion (MJ/kg)			43.1	
MIL-DTL-83133J	Particulate Matter (mg/L)			0.2	
ASTM D 3241 - 16	Thermal Stability Breakpoint				
	Tube Deposit Rating, Visual			2A	X
	Change in Pressure (mmHg)			0	
	Breakpoint (°C)			290	
	Tube Deposit Rating, Ellipsometric (nm)			45	

Dispositions:
For information purposes only.

Approved By	**Date**
Amanda Rowton \\SIGNED\\	07/20/2016*

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Figure A - 3 As Delivered Specification Analysis Results (AFPA) – Page 2 of 2

Quartz Crystal Microbalance (QCM) – Thermal stability characteristics of samples POSF-12831 and POSF-12856 were assessed using a quartz crystal microbalance (QCM) apparatus. The experiment was conducted by placing 60 mL of sample into a batch reactor. The sample was air saturated under room conditions, then closed and heated to 140°C. Measurements of headspace oxygen, temperature, pressure, and mass accumulation were recorded, while the sample was reacted isothermally for 15 hours. These experimental conditions were chosen to highlight the differences in oxidation and deposition tendencies of various jet fuel samples due to differences in trace chemical composition, e.g., heteroatomic species and dissolved metals content. The objective was to investigate what, if any, differences in oxidation and deposition behavior exist between the two samples.

Figure A - 4 shows mass accumulation and headspace oxygen profiles for both fuel samples. As the figure shows, oxygen is completely consumed within about 5 to 6 hours for both samples indicating both fuels are moderate-fast oxidizers under these conditions. The deposition profiles also appear similar, with both fuels giving relatively high amounts of deposit (≥6 μg/cm^2), with POSF-12831 giving about 9.9 μg/cm^2 and POSF-12856 giving about 12.1 μg/cm^2 after 15 hours of thermal stress duration. Both fuel samples demonstrate poor thermal stability under these conditions.

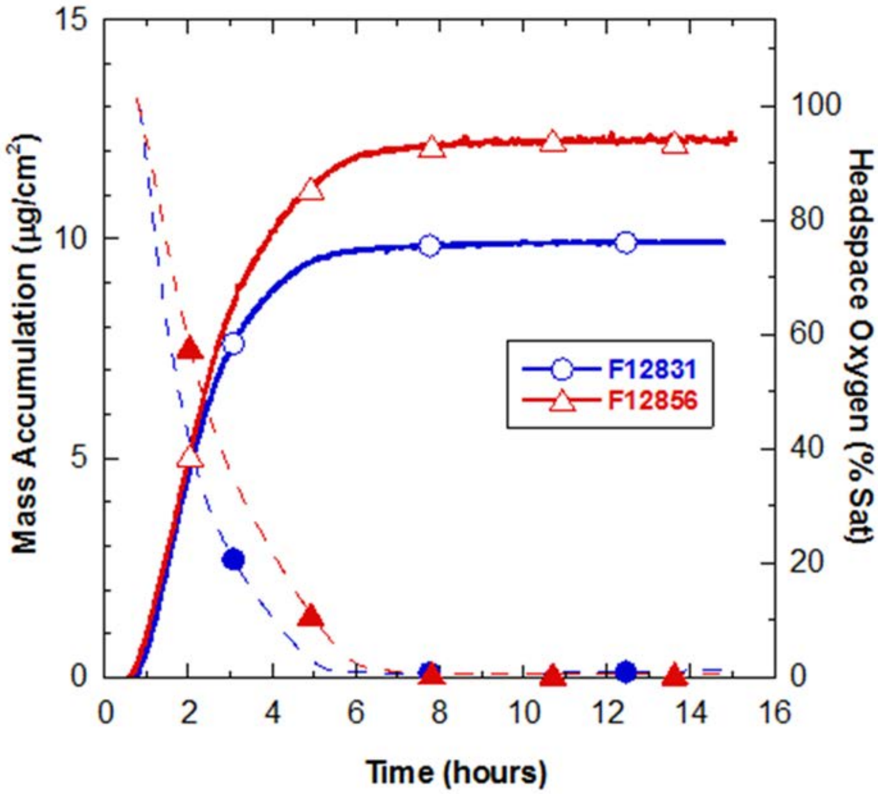

Figure A - 4 QCM profiles of mass accumulation (solid lines, open markers) and headspace oxygen (dashed lines, closed markers) at 140°C.

AFPET LABORATORY REPORT
AFPA/PTPLA
2430 C Street
Building 70, Area B
Wright-Patterson AFB, OH 45433-7632

Lab Report No:2016LA59852001	Date Received:11/01/16 1208 hrs*	Date Sampled: **
Cust Sample No:12831	Date Reported:11/03/16 1411 hrs*	Protocol:FU-AVI-0036
JON: GENERAL FUND		

Sample Submitter:
AFRL/RQTF
1790 Loop Road N
Bldg 490
Wright-Patterson AFB, OH 45433

Reason for Submission: AFRL Research
Product: Aviation Turbine Fuel, Kerosene
Specification: ASTM D 1655 - 16a Grade:Jet A

Qty Submitted: 1 gal
Batch/Lot/Origin: RUN 160 S15

Method	Test	Min	Max	Result	Fail
ASTM D 3241 - 16a	Thermal Stability Breakpoint				
	Tube Deposit Rating, Visual			<3	
	Change in Pressure (mmHg)			0	
	Breakpoint (°C)			290	
	Tube Deposit Rating, Ellipsometric (nm)			85	
ASTM D 3241 - 16a	Thermal Stability @ 280°C				
	Tube Deposit Rating, Visual			1	
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			21	
ASTM D 3241 - 16a	Thermal Stability @ 285°C				
	Tube Deposit Rating, Visual			1	
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			39	
ASTM D 3241 - 16a	Thermal Stability @ 295°C				
	Tube Deposit Rating, Visual			4	X
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			216	

Dispositions:
For information purposes only.

Approved By	Date
Steven Freund \\SIGNED\\	11/03/2016*

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Figure A - 5 POSF-12831 Gulf Coast Fuel Specification Test (RETEST) Run 160, Tank S-15

AFPET LABORATORY REPORT
AFPA/PTPLA
2430 C Street
Building 70, Area B
Wright-Patterson AFB, OH 45433-7632

Lab Report No:2016LA58949001 Date Received:08/11/16 1502 hrs* Date Sampled: **
Cust Sample No:12856 Date Reported:08/25/16 1444 hrs* Protocol:FU-AVI-0036
JON: GENERAL FUND

Sample Submitter:
AFRL/RQTF
1790 Loop Road N
Bldg 490
Wright-Patterson AFB, OH 45433

Reason for Submission: AFRL Research
Product: Aviation Turbine Fuel, Kerosene
Specification: ASTM D 1655 - 15de1 Grade:Jet A

Qty Submitted: 2 gal

Method	Test	Min	Max	Result	Fail
MIL-STD-3004D	Appearance			Pass	
ASTM D 3242 - 11	Total Acid Number (mg KOH/g)		0.10	0.002	
ASTM D 1319 - 15	Aromatics (% vol)		25	18	
ASTM D 3227 - 13	Mercaptan Sulfur (% mass)		0.003	0.001	
ASTM D 4294 - 16e1	Total Sulfur (% mass)		0.30	0.06	
ASTM D 86 - 15	Distillation				
	10% Recovered (°C)		205	192	
	20% Recovered (°C)	Report Only		202	
	50% Recovered (°C)	Report Only		221	
	90% Recovered (°C)	Report Only		252	
	End Point (°C)		300	272	
	Residue (% vol)		1.5	1.2	
	Loss (% vol)		1.5	1.1	
ASTM D 93 - 16	Flash Point (°C)	38		52	
ASTM D 4052 - 15	Density @ 15°C (kg/m³)	775	840	815	
ASTM D 5972 - 16	Freezing Point (°C)		-40	-46	
ASTM D 1322 - 15	Smoke Point (mm)	25		26	
ASTM D 130 - 12	Copper Strip Corrosion (2 h @ 100°C)	1 (Max)		1a	
ASTM D 3241 - 16a	Thermal Stability @ 275°C				
	Tube Deposit Rating, Visual			1A	X
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			43	
ASTM D 3241 - 16a	Thermal Stability @ 285°C				
	Tube Deposit Rating, Visual			4	X
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			224	
ASTM D 3241 - 16a	Thermal Stability @ 290°C				
	Tube Deposit Rating, Visual			4	X
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			213	
ASTM D 381 - 12	Existent Gum (mg/100 mL)		7	2	
ASTM D 1094 - 07 (2013)	Water Reaction Interface Rating	1b (Max)		1	
ASTM D 7224 - 14	MSEP	70		92	
ASTM D 5006 - 11 (2016)	FSII (% vol)	Report Only		0.00	
ASTM D 2624 - 15	Conductivity (pS/m)	50	600	0	X

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Figure A - 6 POSF-12856 Spec Test (POSF-12831 Stressed from Body Tank, Run 151), Pg 1.

AFPET LABORATORY REPORT
AFPA/PTPLA
2430 C Street
Building 70, Area B
Wright-Patterson AFB, OH 45433-7632

Lab Report No:2016LA58949001	Date Received:08/11/16 1502 hrs*	Date Sampled: **
Cust Sample No:12856	Date Reported:08/25/16 1444 hrs*	Protocol:FU-AVI-0036
JON: GENERAL FUND		

Sample Submitter:
AFRL/RQTF
1790 Loop Road N
Bldg 490
Wright-Patterson AFB, OH 45433

Reason for Submission: AFRL Research
Product: Aviation Turbine Fuel, Kerosene
Specification: ASTM D 1655 - 15de1 Grade:Jet A

Qty Submitted: 2 gal

Method	Test	Min	Max	Result	Fail
ASTM D 5001 - 10 (2014)	Lubricity Test (BOCLE) Wear Scar (mm)	Report Only		0.63	
ASTM D 7042 - 16e1	Viscosity @ -20°C (mm²/s)		8.0	6.2	
ASTM D 7171 - 05 (2016)	Hydrogen Content by NMR (% mass)			13.8	
ASTM D 4809 - 13	Net Heat of Combustion (MJ/kg)			43.1	
ASTM D 3241 - 16a	Thermal Stability Breakpoint				
	Tube Deposit Rating, Visual			2	
	Change in Pressure (mmHg)			0	
	Breakpoint (°C)			280	
	Tube Deposit Rating, Ellipsometric (nm)			26	

Dispositions:
For information purposes only.

Approved By	**Date**
Scott D. Dible \\SIGNED\\	08/25/2016*

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Figure A - 7 POSF-12856 Spec Test (POSF-12831 Stressed from Body Tank, Run 151), Pg 2.

AFPET LABORATORY REPORT
AFPA/PTPLA
2430 C Street
Building 70, Area B
Wright-Patterson AFB, OH 45433-7632

Lab Report No:2016LA59080001 | Date Received:08/23/16 1327 hrs* | Date Sampled: **
Cust Sample No:12862 | Date Reported:09/07/16 1247 hrs* | Protocol:FU-AVI-0036
JON: GENERAL FUND

Sample Submitter:
AFRL/RQTF
1790 Loop Road N
Bldg 490
Wright-Patterson AFB, OH 45433

Reason for Submission: AFRL Research
Product: Aviation Turbine Fuel, Kerosene
Specification: ASTM D 1655 - 16a Grade:Jet A

Qty Submitted: 2 gal
Batch/Lot/Origin: FSS RUN 152 BODY TANK

Method	Test	Min	Max	Result	Fail
MIL-STD-3004D	Appearance			Pass	
ASTM D 3242 - 11	Total Acid Number (mg KOH/g)		0.10	0.001	
ASTM D 1319 - 15	Aromatics (% vol)		25	14	
ASTM D 3227 - 13	Mercaptan Sulfur (% mass)		0.003	0.001	
ASTM D 4294 - 16e1	Total Sulfur (% mass)		0.30	0.06	
ASTM D 86 - 16a	Distillation				
	10% Recovered (°C)		205	192	
	20% Recovered (°C)	Report Only		203	
	50% Recovered (°C)	Report Only		221	
	90% Recovered (°C)	Report Only		251	
	End Point (°C)		300	271	
	Residue (% vol)		1.5	1.2	
	Loss (% vol)		1.5	0.8	
ASTM D 93 - 16	Flash Point (°C)	38		52	
ASTM D 4052 - 15	Density @ 15°C (kg/m³)	775	840	815	
ASTM D 5972 - 16	Freezing Point (°C)		-40	-46	
ASTM D 445 - 15a	Viscosity @ -20°C (mm²/s)		8.0	6.2	
ASTM D 1322 - 15	Smoke Point (mm)	25		26	
ASTM D 130 - 12	Copper Strip Corrosion (2 h @ 100°C)	1 (Max)		1a	
ASTM D 3241 - 16a	Thermal Stability @ 280°C				
	Tube Deposit Rating, Visual			1	
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			31	
ASTM D 3241 - 16a	Thermal Stability @ 295°C				
	Tube Deposit Rating, Visual			4A	X
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			114	
ASTM D 381 - 12	Existent Gum (mg/100 mL)		7	3	
ASTM D 1094 - 07 (2013)	Water Reaction Interface Rating	1b (Max)		1	
ASTM D 7224 - 14	MSEP	70		95	
ASTM D 5006 - 11 (2016)	FSII (% vol)	Report Only		0.00	
ASTM D 2624 - 15	Conductivity (pS/m)	50	600	0	X

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** Date as provided by customer

Figure A - 8 POSF-12862 Spec Test (POSF-12831, Run 152 Stressed from Body Tank), Pg 1.

AFPET LABORATORY REPORT
AFPA/PTPLA
2430 C Street
Building 70, Area B
Wright-Patterson AFB, OH 45433-7632

Lab Report No:2016LA59080001 Date Received:08/23/16 1327 hrs* Date Sampled: **
Cust Sample No:12862 Date Reported:09/07/16 1247 hrs* Protocol:FU-AVI-0036
JON: GENERAL FUND

Sample Submitter:
AFRL/RQTF
1790 Loop Road N
Bldg 490
Wright-Patterson AFB, OH 45433

Reason for Submission: AFRL Research
Product: Aviation Turbine Fuel, Kerosene
Specification: ASTM D 1655 - 16a Grade:Jet A

Qty Submitted: 2 gal
Batch/Lot/Origin: FSS RUN 152 BODY TANK

Method	Test	Min	Max	Result	Fail
ASTM D 5001 - 10 (2014)	Lubricity Test (BOCLE) Wear Scar (mm)	Report Only		0.66	
ASTM D 7171 - 05 (2016)	Hydrogen Content by NMR (% mass)			13.9	
ASTM D 4809 - 13	Net Heat of Combustion (MJ/kg)			43.2	
MIL-DTL-83133J	Particulate Matter (mg/L)			0.1	
ASTM D 3241 - 16a	Thermal Stability Breakpoint				
	Tube Deposit Rating, Visual			3A	X
	Change in Pressure (mmHg)			0	
	Breakpoint (°C)			290	
	Tube Deposit Rating, Ellipsometric (nm)			83	

Dispositions:
For information purposes only.

Approved By	**Date**
Steven Freund \\SIGNED\\	09/07/2016*

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Figure A - 9 POSF-12862 Spec Test (POSF-12831, Run 152 Stressed from Body Tank), Pg 2.

AFPET LABORATORY REPORT
AFPA/PTPLA
2430 C Street
Building 70, Area B
Wright-Patterson AFB, OH 45433-7632

Lab Report No:2016LA60301001 Date Received:12/02/16 1035 hrs* Date Sampled: **
Cust Sample No:12914 Date Reported:12/12/16 1300 hrs* Protocol:FU-AVI-0036
JON: GENERAL FUND

Sample Submitter:
AFRL/RQTF
1790 Loop Road N
Bldg 490
Wright-Patterson AFB, OH 45433

Reason for Submission: AFRL Research
Product: Aviation Turbine Fuel, Kerosene
Specification: ASTM D 1655 - 16a Grade:Jet A

Qty Submitted: 1 gal

Method	Test	Min	Max	Result	Fail
ASTM D 3241 - 16a	Thermal Stability Breakpoint				
	Tube Deposit Rating, Visual			3A	X
	Change in Pressure (mmHg)			0	
	Breakpoint (°C)			295	
	Tube Deposit Rating, Ellipsometric (nm)			47	
ASTM D 3241 - 16a	Thermal Stability @ 285°C				
	Tube Deposit Rating, Visual			1	
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			19	
ASTM D 3241 - 16a	Thermal Stability @ 300°C				
	Tube Deposit Rating, Visual			4	X
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			119	

Dispositions:
For information purposes only.

Approved By	Date
Scott D. Dible \\SIGNED\\	12/12/2016*

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Figure A - 10 POSF-12914 (POSF-12831 Run 163 Stressed, BT)

APPENDIX B
Fuel Analysis Compilation – POSF-12843, Fort McCoy Fuel

AFPET LABORATORY REPORT
AFPA/PTPLA
2430 C Street
Building 70, Area B
Wright-Patterson AFB, OH 45433-7632

Lab Report No:2016LA58653001 Date Received:07/19/16 1311 hrs* Date Sampled: **
Cust Sample No:12843 Date Reported:07/28/16 1559 hrs* Protocol:FU-AVI-0191
JON: GENERAL FUND

Sample Submitter:
AFRL/RQTF
1790 Loop Road N
Bldg 490
Wright-Patterson AFB, OH 45433

Reason for Submission: AFRL Research
Product: Aviation Turbine Fuel, Kerosene
Specification: ASTM D 1655 - 15de1 Grade:Jet A (F-24)

Qty Submitted: 3 gal

Method	Test	Min	Max	Result	Fail
ASTM D 3242 - 11	Total Acid Number (mg KOH/g)		0.10	0.005	
ASTM D 1319 - 15	Aromatics (% vol)		25	18.0	
ASTM D 3227 - 13	Mercaptan Sulfur (% mass)		0.003	0.000	
ASTM D 4294 - 16e1	Total Sulfur (% mass)		0.30	0.22	
ASTM D 86 - 15	Distillation				
	10% Recovered (°C)		205	182	
	20% Recovered (°C)	Report Only		191	
	50% Recovered (°C)	Report Only		212	
	90% Recovered (°C)	Report Only		253	
	End Point (°C)		300	276	
	Residue (% vol)		1.5	1.3	
	Loss (% vol)		1.5	1.2	
ASTM D 93 - 16	Flash Point (°C)	38		48	
ASTM D 4052 - 15	Density @ 15°C (kg/m³)	775	840	816	
ASTM D 5972 - 16	Freezing Point (°C)		-40	-46	
ASTM D 445 - 15a	Viscosity @ -20°C (mm²/s)		8.0	5.5	
ASTM D 1322 - 15	Smoke Point (mm)	25		25.0	
ASTM D 130 - 12	Copper Strip Corrosion (2 h @ 100°C)	1 (Max)		1a	
ASTM D 3241 - 16a	Thermal Stability @ 260°C				
	Change in Pressure (mmHg)		25	0	
	Tube Deposit Rating, Visual	<3 (Max)		1	
	Tube Deposit Rating, Ellipsometric (nm)		85	18	
ASTM D 381 - 12	Existent Gum (mg/100 mL)		7	2	
ASTM D 5006 - 11 (2016)	FSII (% vol)	0.07	0.10	0.09	
ASTM D 2624 - 15	Conductivity (pS/m)	50	600	161	
ASTM D 7171 - 05 (2016)	Hydrogen Content by NMR (% mass)	Report Only		13.7	
ASTM D 5001 - 10 (2014)	Lubricity Test (BOCLE) Wear Scar (mm)	Report Only		0.55	
ASTM D 4809 - 13	Net Heat of Combustion (MJ/kg)	42.8		43.1	
ASTM D 7224 - 14	MSEP	Report Only		62	
ASTM D 7797 - 16	Fatty Acid Methyl Esters (FAME) Content (mg/kg)			0	
MIL-DTL-83133J	Filtration Time (min)			5	
MIL-DTL-83133J	Particulate Matter (mg/L)			0.1	
ASTM D 3241 - 16a	Thermal Stability Breakpoint				
	Tube Deposit Rating, Visual			1	

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Figure B - 1 Specification Testing Results, Ft. McCoy Fuel As=Delivered, Page 1

AFPET LABORATORY REPORT
AFPA/PTPLA
2430 C Street
Building 70, Area B
Wright-Patterson AFB, OH 45433-7632

Lab Report No:2016LA58653001   Date Received:07/19/16 1311 hrs*   Date Sampled: **
Cust Sample No:12843   Date Reported:07/28/16 1559 hrs*   Protocol:FU-AVI-0191
JON: GENERAL FUND

Sample Submitter:
AFRL/RQTF
1790 Loop Road N
Bldg 490
Wright-Patterson AFB, OH 45433

Reason for Submission: AFRL Research
Product: Aviation Turbine Fuel, Kerosene
Specification: ASTM D 1655 - 15de1 Grade:Jet A (F-24)

Qty Submitted: 3 gal

Method	Test	Min	Max	Result	Fail
	Change in Pressure (mmHg)			0	
	Breakpoint (°C)			265	
	Tube Deposit Rating, Ellipsometric (nm)			31	
ASTM D 1094 - 07 (2013)	Water Reaction Interface Rating			1	
ASTM D 3241 - 16a	Thermal Stability @ 270°C				
	Tube Deposit Rating, Visual			>4A	X
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			205	
ASTM D 3241 - 16a	Thermal Stability @ 275°C				
	Tube Deposit Rating, Visual			>4AP	X
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			219	

Dispositions:
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Approved By	**Date**
Scott D. Dible \\SIGNED\\	07/28/2016*

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Figure B - 2 Specification Testing Results, Ft. McCoy Fuel As-Delivered, Page 2.

AFPET LABORATORY REPORT
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Building 70, Area B
Wright-Patterson AFB, OH 45433-7632

Lab Report No:2016LA59180001 Date Received:08/30/16 1010 hrs* Date Sampled: 08/29/2016**
Cust Sample No:12843 Date Reported:09/14/16 1047 hrs* Protocol:FU-AVI-0036
JON: GENERAL FUND

Sample Submitter:
AFRL/RQTF
1790 Loop Road N
Bldg 490
Wright-Patterson AFB, OH 45433

Reason for Submission: AFRL Research
Product: Aviation Turbine Fuel, Kerosene
Specification: ASTM D 1655 - 16a Grade:Jet A

Qty Submitted: 2 gal

Method	Test	Min	Max	Result	Fail
ASTM D 3227 - 13	Mercaptan Sulfur (% mass)		0.003	0.000	
ASTM D 4294 - 16e1	Total Sulfur (% mass)		0.30	0.21	
ASTM D 3241 - 16a	Thermal Stability @ 275°C				
	Tube Deposit Rating, Visual			>4AP	X
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			213	
ASTM D 3241 - 16a	Thermal Stability @ 290°C				
	Tube Deposit Rating, Visual			>4P	X
	Change in Pressure (mmHg)			7	
	Tube Deposit Rating, Ellipsometric (nm)			225	
ASTM D 3241 - 16a	Thermal Stability Breakpoint				
	Tube Deposit Rating, Visual			1	
	Change in Pressure (mmHg)			0	
	Breakpoint (°C)			260	
	Tube Deposit Rating, Ellipsometric (nm)			34	
ASTM D 3241 - 16a	Thermal Stability @ 265°C				
	Tube Deposit Rating, Visual			>4A	X
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			208	

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Figure B - 3 JFTOT Breakpoint Recheck, Aug 2016, 260 °C

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AFPA/PTPLA
2430 C Street
Building 70, Area B
Wright-Patterson AFB, OH 45433-7632

Lab Report No:2016LA59623001   Date Received:10/12/16 1501 hrs*   Date Sampled: **
Cust Sample No:12843 TANK S3   Date Reported:10/19/16 1431 hrs*   Protocol:FU-AVI-0191
JON: GENERAL FUND

Sample Submitter:
AFRL/RQTF
1790 Loop Road N
Bldg 490
Wright-Patterson AFB, OH 45433

Reason for Submission: AFRL Research
Product: Aviation Turbine Fuel, Kerosene
Specification: ASTM D 1655 - 16a Grade:Jet A (F-24)

Qty Submitted: 2 gal

Method	Test	Min	Max	Result	Fail
ASTM D 3241 - 16a	Thermal Stability Breakpoint				
	Tube Deposit Rating, Visual			3	X
	Change in Pressure (mmHg)			0	
	Breakpoint (°C)			250	
	Tube Deposit Rating, Ellipsometric (nm)			79	
ASTM D 3241 - 16a	Thermal Stability @ 245°C				
	Tube Deposit Rating, Visual			2	
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			36	
ASTM D 3241 - 16a	Thermal Stability @ 255°C				
	Tube Deposit Rating, Visual			<4	X
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			213	
ASTM D 3241 - 16a	Thermal Stability @ 265°C				
	Tube Deposit Rating, Visual			4	X
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			223	

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Figure B - 4 JFTOT Breakpoint Determination October 2016 - POSF-12843 from Tank S-3

AFPET LABORATORY REPORT
AFPA/PTPLA
2430 C Street
Building 70, Area B
Wright-Patterson AFB, OH 45433-7632

Lab Report No:2016LA59623002 Date Received:10/12/16 1501 hrs* Date Sampled: **
Cust Sample No:12843 TANK S14 Date Reported:10/19/16 1432 hrs* Protocol:FU-AVI-0191
JON: GENERAL FUND

Sample Submitter:
AFRL/RQTF
1790 Loop Road N
Bldg 490
Wright-Patterson AFB, OH 45433

Reason for Submission: AFRL Research
Product: Aviation Turbine Fuel, Kerosene
Specification: ASTM D 1655 - 16a Grade:Jet A (F-24)

Qty Submitted: 2 gal

Method	Test	Min	Max	Result	Fail
ASTM D 3241 - 16a	Thermal Stability Breakpoint				
	Tube Deposit Rating, Visual			2	
	Change in Pressure (mmHg)			0	
	Breakpoint (°C)			260	
	Tube Deposit Rating, Ellipsometric (nm)			34	
ASTM D 3241 - 16a	Thermal Stability @ 255°C				
	Tube Deposit Rating, Visual			2	
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			61	
ASTM D 3241 - 16a	Thermal Stability @ 265°C				
	Tube Deposit Rating, Visual			>4	X
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			196	

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Approved By	**Date**
Steven Freund	10/19/2016*
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Figure B - 5 JFTOT Breakpoint Determination October 2016 - POSF-12843 from Tank S-14

AFPET LABORATORY REPORT
AFPA/PTPLA
2430 C Street
Building 70, Area B
Wright-Patterson AFB, OH 45433-7632

Lab Report No:2016LA59414001	Date Received:09/21/16 0835 hrs*	Date Sampled: **
Cust Sample No:12899	Date Reported:10/04/16 1255 hrs*	Protocol:FU-AVI-0191
JON: GENERAL FUND		

Sample Submitter:
AFRL/RQTF
1790 Loop Road N
Bldg 490
Wright-Patterson AFB, OH 45433

Reason for Submission: AFRL Research
Product: Aviation Turbine Fuel, Kerosene
Specification: ASTM D 1655 - 16a Grade:Jet A (F-24)

Qty Submitted: 1 gal
Batch/Lot/Origin: FSS RUN 155

Method	Test	Min	Max	Result	Fail
ASTM D 3227 - 13	Mercaptan Sulfur (% mass)		0.003	0.000	
ASTM D 4294 - 16e1	Total Sulfur (% mass)		0.30	0.22	
ASTM D 3241 - 16a	Thermal Stability Breakpoint				
	Tube Deposit Rating, Visual			<4A	X
	Change in Pressure (mmHg)			0	
	Breakpoint (°C)			320	
	Tube Deposit Rating, Ellipsometric (nm)			81	
ASTM D 3241 - 16a	Thermal Stability @ 325°C				
	Tube Deposit Rating, Visual			4A	X
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			98	
ASTM D 3241 - 16a	Thermal Stability @ 330°C				
	Tube Deposit Rating, Visual			4A	X
	Change in Pressure (mmHg)			0	
	Tube Deposit Rating, Ellipsometric (nm)			101	

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Figure B - 6 JFTOT Breakpoint POSF-12899 (POSF-12843 with 256 mg/L Spec-Aid 8Q462)

AFPET LABORATORY REPORT
AFPA/PTPLA
2430 C Street
Building 70, Area B
Wright-Patterson AFB, OH 45433-7632

Lab Report No:2016LA60015001 Date Received:11/15/16 0855 hrs* Date Sampled: **
Cust Sample No:12911 Date Reported:11/30/16 1446 hrs* Protocol:FU-AVI-0036
JON: GENERAL FUND

Sample Submitter:
AFRL/RQTF
1790 Loop Road N
Bldg 490
Wright-Patterson AFB, OH 45433

Reason for Submission: AFRL Research
Product: Aviation Turbine Fuel, Kerosene
Specification: ASTM D 1655 - 16a Grade:Jet A

Qty Submitted: 2 gal
Batch/Lot/Origin: R162 COND. TANK

Method	Test	Min	Max	Result
ASTM D 3242 - 11	Total Acid Number (mg KOH/g)		0.10	0.004
ASTM D 3227 - 16	Mercaptan Sulfur (% mass)		0.003	0.000
ASTM D 4294 - 16e1	Total Sulfur (% mass)		0.30	0.22
ASTM D 1322 - 15	Smoke Point (mm)	25		26
ASTM D 130 - 12	Copper Strip Corrosion (2 h @ 100°C)		1 (Max)	1a
ASTM D 3241 - 16a	Thermal Stability @ 300°C			
	Tube Deposit Rating, Visual			1
	Change in Pressure (mmHg)			0
	Tube Deposit Rating, Ellipsometric (nm)			41
ASTM D 3241 - 16a	Thermal Stability @ 325°C			
	Tube Deposit Rating, Visual			2
	Change in Pressure (mmHg)			242
	Tube Deposit Rating, Ellipsometric (nm)			27
ASTM D 381 - 12	Existent Gum (mg/100 mL)		7	<1
ASTM D 1094 - 07 (2013)	Water Reaction Interface Rating		1b (Max)	1
ASTM D 5006 - 11 (2016)	FSII (% vol)		Report Only	0.08
ASTM D 2624 - 15	Conductivity (pS/m)	50	600	61
ASTM D 5001 - 10 (2014)	Lubricity Test (BOCLE) Wear Scar (mm)		Report Only	0.53
MIL-DTL-83133J	Particulate Matter (mg/L)			0.4
ASTM D 3241 - 16a	Thermal Stability Breakpoint			
	Tube Deposit Rating, Visual			1
	Change in Pressure (mmHg)			12
	Breakpoint (°C)			315
	Tube Deposit Rating, Ellipsometric (nm)			19
ASTM D 3241 - 16a	Thermal Stability @ 320°C			
	Tube Deposit Rating, Visual			1
	Change in Pressure (mmHg)			86
	Tube Deposit Rating, Ellipsometric (nm)			24
ASTM D 3241 - 16a	Thermal Stability @ 335°C			
	Tube Deposit Rating, Visual			1
	Change in Pressure (mmHg)			108
	Tube Deposit Rating, Ellipsometric (nm)			51
ASTM D 3241 - 16a	Thermal Stability @ 345°C			

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Figure B - 7 Spec Analysis of POSF-12911 (POSF-12843 with 5.7mg/l Metal Deactivator (MDA)), Page 1of 2

AFPET LABORATORY REPORT
AFPA/PTPLA
2430 C Street
Building 70, Area B
Wright-Patterson AFB, OH 45433-7632

Lab Report No:2016LA60015001   Date Received:11/15/16 0855 hrs*   Date Sampled: **
Cust Sample No:12911   Date Reported:11/30/16 1446 hrs*   Protocol:FU-AVI-0036
JON: GENERAL FUND

Sample Submitter:
AFRL/RQTF
1790 Loop Road N
Bldg 490
Wright-Patterson AFB, OH 45433

Reason for Submission: AFRL Research
Product: Aviation Turbine Fuel, Kerosene
Specification: ASTM D 1655 - 16a Grade:Jet A

Qty Submitted: 2 gal
Batch/Lot/Origin: R162 COND. TANK

Method	Test	Min	Max	Result
	Tube Deposit Rating, Visual			2
	Change in Pressure (mmHg)			144
	Tube Deposit Rating, Ellipsometric (nm)			28
ASTM D 3241 - 16a	Thermal Stability @ 350°C			
	Tube Deposit Rating, Visual			2
	Change in Pressure (mmHg)			138
	Tube Deposit Rating, Ellipsometric (nm)			41

Dispositions:
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Approved By	**Date**
Steven Freund \\SIGNED\\	11/30/2016*

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Figure B - 8 Spec Analysis of POSF-12911 (POSF-12843 with 5.7mg/L Metal Deactivator (MDA)), Page 2 of 2

Quartz Crystal Microbalance (QCM) – Thermal stability characteristics of sample POSF-12843 were assessed using a quartz crystal microbalance (QCM) apparatus. The experiment was conducted by placing 60 mL of sample into a batch reactor. The sample was air saturated under room conditions, then closed and heated to 140°C. Measurements of headspace oxygen, temperature, pressure, and mass accumulation were recorded, while the sample was reacted isothermally for 15 hours. These experimental conditions were chosen to highlight the differences in oxidation and deposition tendencies of various jet fuel samples due to differences in trace chemical composition, e.g., heteroatomic species and dissolved metals content. The objective was to investigate what, if any, differences in oxidation and deposition behavior exist between the two samples.

Figure B-9 shows mass accumulation and headspace oxygen profiles for both Gulf Coast Jet A (POSF-12831fuel samples. As the figure shows, oxygen is completely consumed within about 12 to 13 hours for indicating the fuels is a moderate oxidizers under these conditions. The fuel gives high amounts of deposit (≥11 μg/cm^2) after 15 hours of thermal stress duration. This fuel sample exhibit poor thermal stability under these conditions.

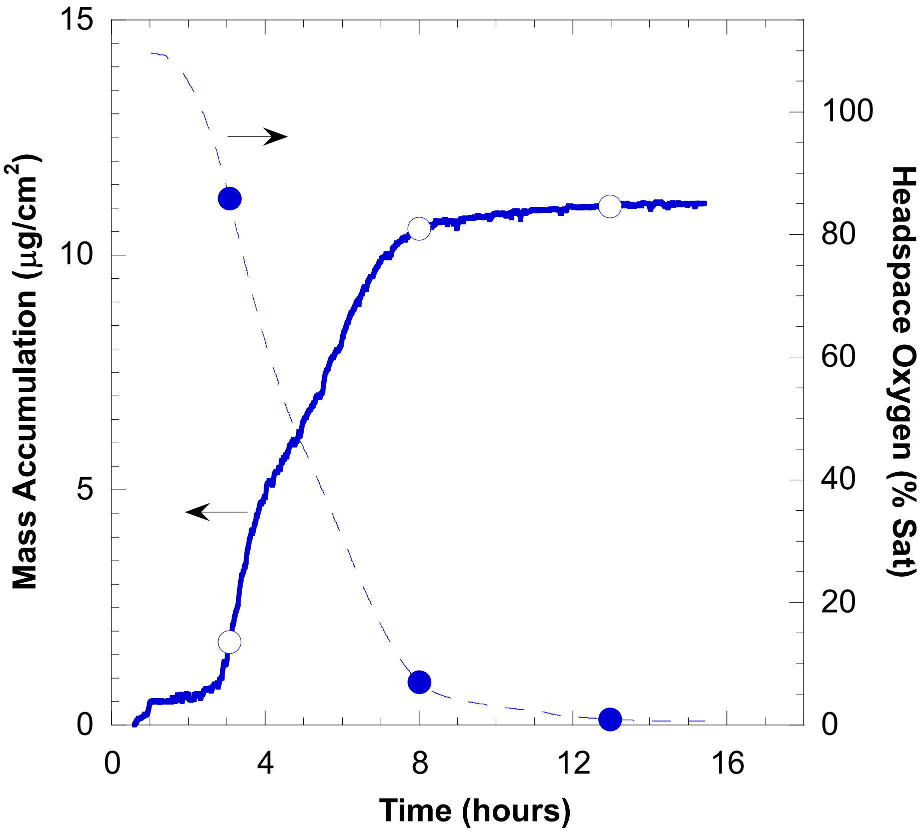


Figure B - 9 Mass accumulation and headspace oxygen profiles for fuel F12843 (sampled on 30-Aug-16), run at 140°C.

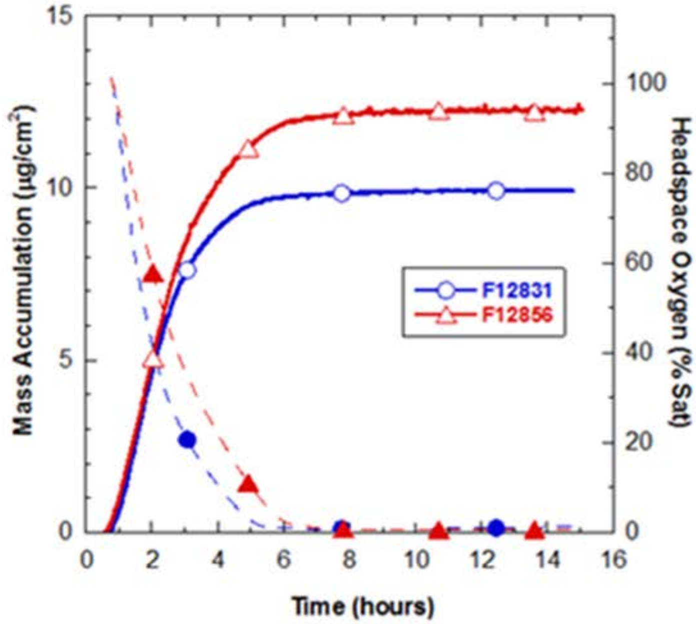


Figure 1. QCM profiles of mass accumulation (solid lines, open markers) and headspace oxygen (dashed lines, closed markers) at 140°C.

Quartz Crystal Microbalance (QCM) – Thermal stability characteristics of samples POSF-12831 and POSF-12856 were assessed using a quartz crystal microbalance (QCM) apparatus. The experiment was conducted by placing 60 mL of sample into a batch reactor. The sample was air saturated under room conditions, then closed and heated to 140°C. Measurements of headspace oxygen, temperature, pressure, and mass accumulation were recorded, while the sample was reacted isothermally for 15 hours. These experimental conditions were chosen to highlight the differences in oxidation and deposition tendencies of various jet fuel samples due to differences in trace chemical composition, e.g., heteroatomic species and dissolved metals content. The objective was to investigate what, if any, differences in oxidation and deposition behavior exist between the two samples.

Figure 1 shows mass accumulation and headspace oxygen profiles for both fuel samples. As the figure shows, oxygen is completely consumed within about 5 to 6 hours for both samples indicating both fuels are moderate-fast oxidizers under these conditions. The deposition profiles also appear similar, with both fuels giving relatively high amounts of deposit (≥6 µg/cm2), with POSF-12831 giving about 9.9 µg/cm2 and POSF-12856 giving about 12.1 µg/cm2 after 15 hours of thermal stress duration. Both fuel samples demonstrate poor thermal stability under these conditions.

Figure B - 10 QCM POSF-12831 and POSF-12856

APPENDIX C
Description and Operation of the Fuel System Simulator (FSS)

Introduction to the FSS

The FSS is a complex test rig that simulates an advanced military aircraft fuel system by simulating all of the major components of the airframe and engine fuel systems. In addition to component simulation, scaled flow, pressure and temperature conditions of a fuel system in advanced aircraft are also simulated. Although originally designed to simulate the F-15 with the P&W F100 engine, it has been modified to simulate the more advanced F-22 with the F119 engine. A simple block diagram flow schematic of the FSS is given in Figure C - 1 and a more detailed flow diagram showing all the major airframe and engine components is shown in Figure C - 2 FSS Process Flow Diagram Figure C - 2

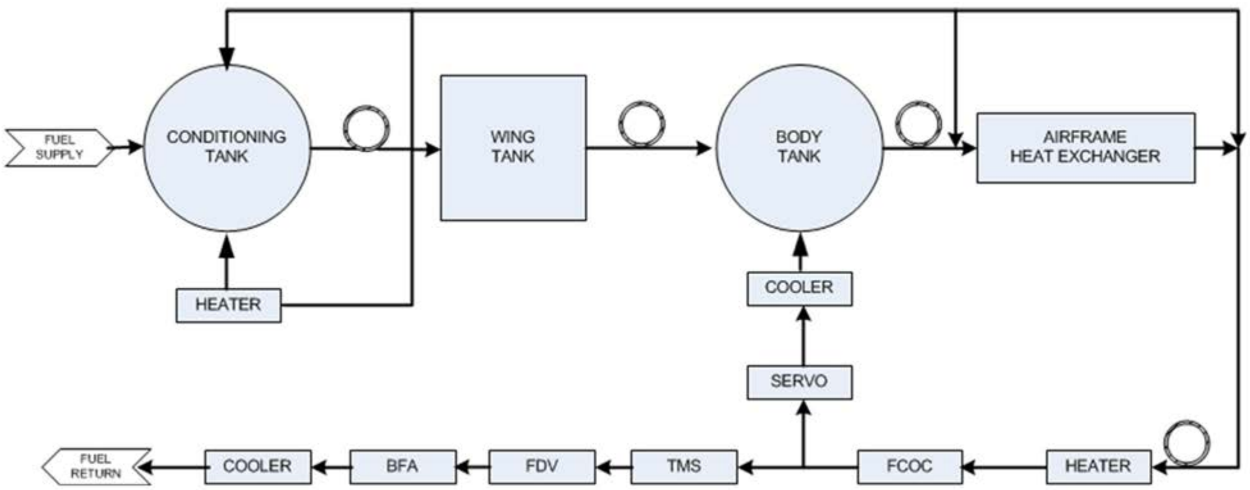
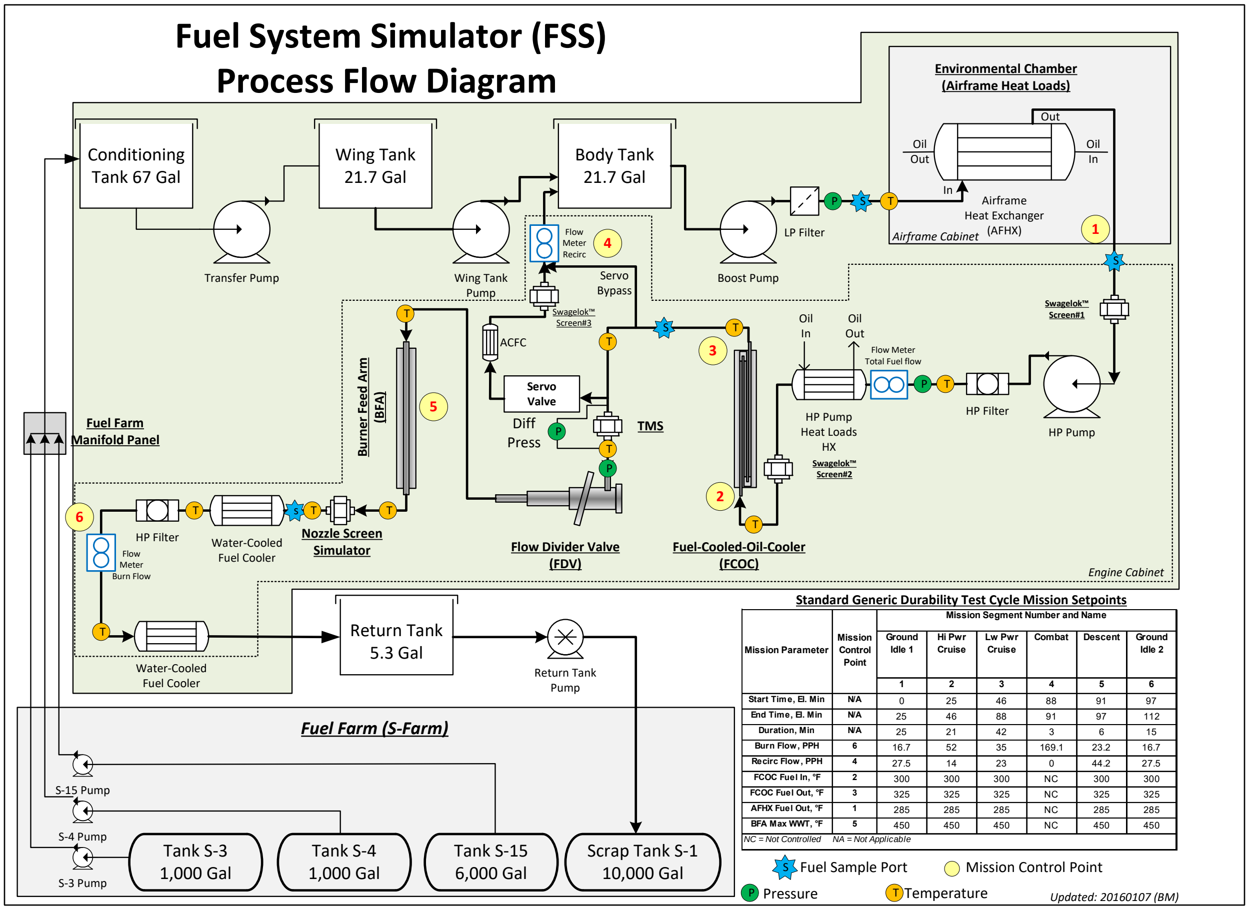


Figure C - 1 FSS Block Flow Diagram



Standard Generic Durability Test Cycle Mission Setpoints

Mission Parameter	Mission Control Point	Mission Segment Number and Name					
		Ground Idle 1	Hi Pwr Cruise	Lw Pwr Cruise	Combat	Descent	Ground Idle 2
		1	2	3	4	5	6
Start Time, El. Min	N/A	0	25	46	88	91	97
End Time, El. Min	N/A	25	46	88	91	97	112
Duration, Min	N/A	25	21	42	3	6	15
Burn Flow, PPH	6	16.7	52	35	169.1	23.2	16.7
Recirc Flow, PPH	4	27.5	14	23	0	44.2	27.5
FCOC Fuel In, °F	2	300	300	300	NC	300	300
FCOC Fuel Out, °F	3	325	325	325	NC	325	325
AFHX Fuel Out, °F	1	285	285	285	NC	285	285
BFA Max WWT, °F	5	450	450	450	NC	450	450

NC = Not Controlled NA = Not Applicable

Figure C - 2 FSS Process Flow Diagram

FSS Detailed Description

The FSS consists of three major subsystems – the Conditioning Subsystem, the Airframe Subsystem (including and Altitude Control subsystem) and the Engine Subsystem. These subsystems work together to form a complete aircraft fuel system simulation system. The Conditioning Subsystem pre-conditions fuel prior to a simulation test. The Airframe Subsystem simulates all of the airframe fuel system components and functions, including Altitude. The Engine Subsystem simulates all of the engine fuel system components and functions. A more detailed description of these subsystems is given in the following pages.

Fuel Conditioning System

Fuel supplied to the FSS during normal operations is supplied from the fuel farm located adjacent to the test facility. Since the FSS operates across various seasons, and since the fuel lines feeding the FSS test cell are exposed to outside temperature and weather conditions, this incoming test fuel temperature can vary from single-digit to in excess of 100 °F. The temperature of the feed fuel can have a significant impact on the fuel temperature profile of the FSS during a run. To avoid this, fuel coming into the test cell from S-Farm is pumped into a 67-gallon Conditioning Tank. In this tank fuel is heated to 100 °F using a fuel/oil heat exchanger before testing. Incoming fuel from the S-Farm has never exceeded 100 °F so no provision for cooling of this fuel down to 100 °F has been made. Preparation of the fuel to a standard 100 °F assures that each mission and each Run always starts with fuel at the same temperature. This allows for comparisons between heater current loads, etc. between missions and between Runs.

Conditioning Tank (CT)

Figure C - 3 shows the Conditioning Tank (left side, farthest away) which, along with some pumps and valves, constitutes the Fuel Conditioning subsystem. The Wing Tank (WT) is also shown in Figure C - 3 (center, closest) but it is part of the Airframe Fuel System subsystem. A simplified diagram of the key elements of the Conditioning Tank is shown in Figure C - 4. A partial PID of the conditioning tank is shown in Figure C - 5.

Internal to the tank is an injector nozzle similar to that found in aircraft (Figure C - 6). This injector creates turbulence inside the tank during fill and recirculation operations and helps maintain uniform temperature and fuel composition conditions while the fuel is being conditioned and during the test.

Figure C - 3 Conditioning Tank (Left) and Wing Tank (Right)

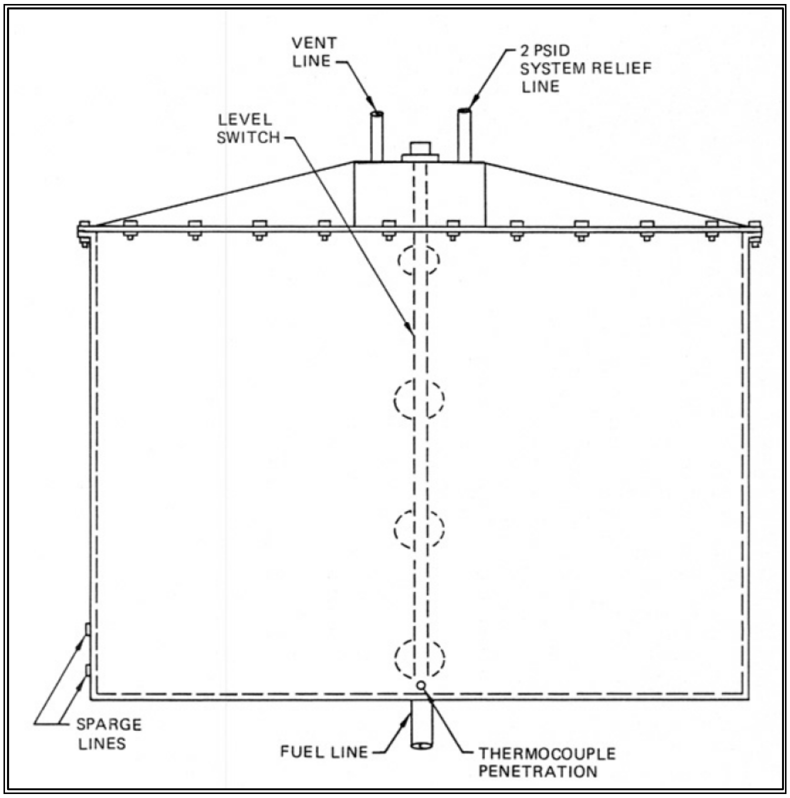


Figure C - 4 Conditioning Tank

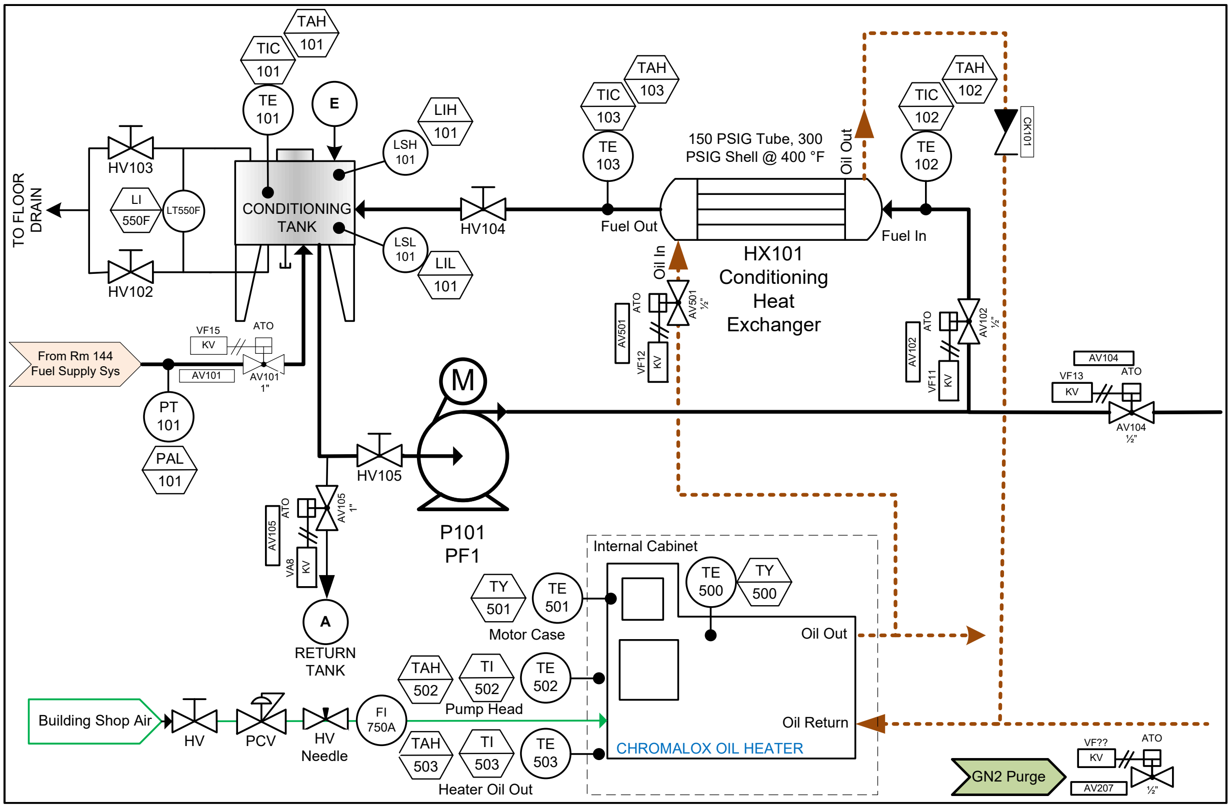


Figure C - 5 Conditioning Tank PID

Figure C - 6 Injector Assembly Interior to Conditioning Tank. Yellow Fluid Is Fuel

In 2015, the CT was augmented with a Plexiglas window to allow viewing and photographing of the inside of the tank during operation (Figure C - 7). The image that appears to be superimposed above the injector in Figure C-6 is a reflection created by that Plexiglas window.

Figure C - 7 Observation Windows, Conditioning Tank

Airframe Fuel System Simulator

The next major subsystem in the FSS is the Airframe Fuel System Simulator. As expected, this subsystem attempts to simulate the fuel handling, flows, temperatures and pressures of the aircraft airframe fuel system. It consists of a Wing Tank (WT), ab Body Tank (BT), an Airframe Heat Exchanger (AFHX) contained within the Environmental Chamber (EC), and the Altitude Tank/Altitude Control.

Wing Tank (WT)

Figure C - 3 shows the Conditioning and Wing tanks with the Wing Tank in the foreground. A PID of the wing and body tanks is shown in Figure C - 9. The Wing Tank holds 21.7 gallons of fuel. It is fabricated entirely from 316 Stainless Steel. As with the CT, the WT was recently reconfigured with a Plexiglas observation window to allow viewing inside the tank during operation.

Body Tank (BT)

For most aircraft, fuel from the wing tanks gets to the engine through one or more internal fuselage tanks. This is done for several reasons, one of which is for CG (center of gravity) control for the aircraft. The fuselage tanks are usually a main storage tank and one or more engine feed tanks. These tanks do not typically experience substantial heating since they are located internal to the airframe. However, since most aircraft recirculate hot fuel from either the downstream airframe components or from the engine(s), the fuel in these tanks is heated due to this recirculated hot fuel.

The BT has a capacity of 21.7 gallons and is constructed entirely of 316 Stainless Steel. Fuel from this tank feeds the ‘boost pump’ (PF3) which feeds the rest of the system. Figure C - 8 shows a simplified drawing of the tank. Figure C - 9 shows the PID of the BT area (including the WT). The ‘boost pump’ is an Oberdorfer centrifugal pump. Since this pump is capable of output in significant excess of FSS system requirements, a bypass loop has been constructed and is manually adjusted so that the output of the BT section meets the pressure and flow requirements of the downstream components.

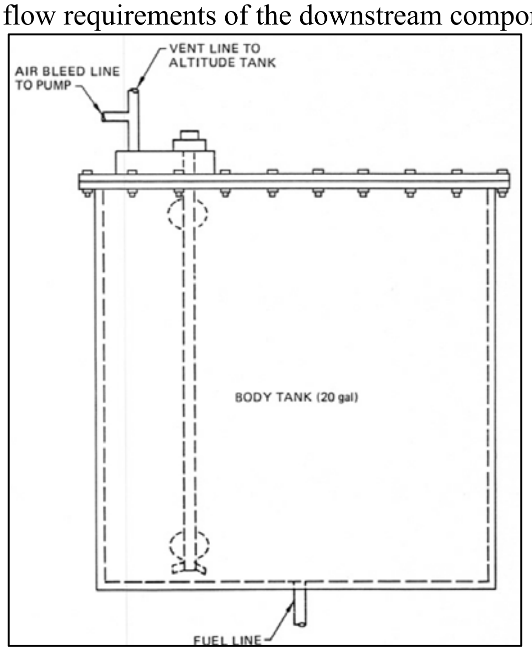


Figure C - 8 Body Tank

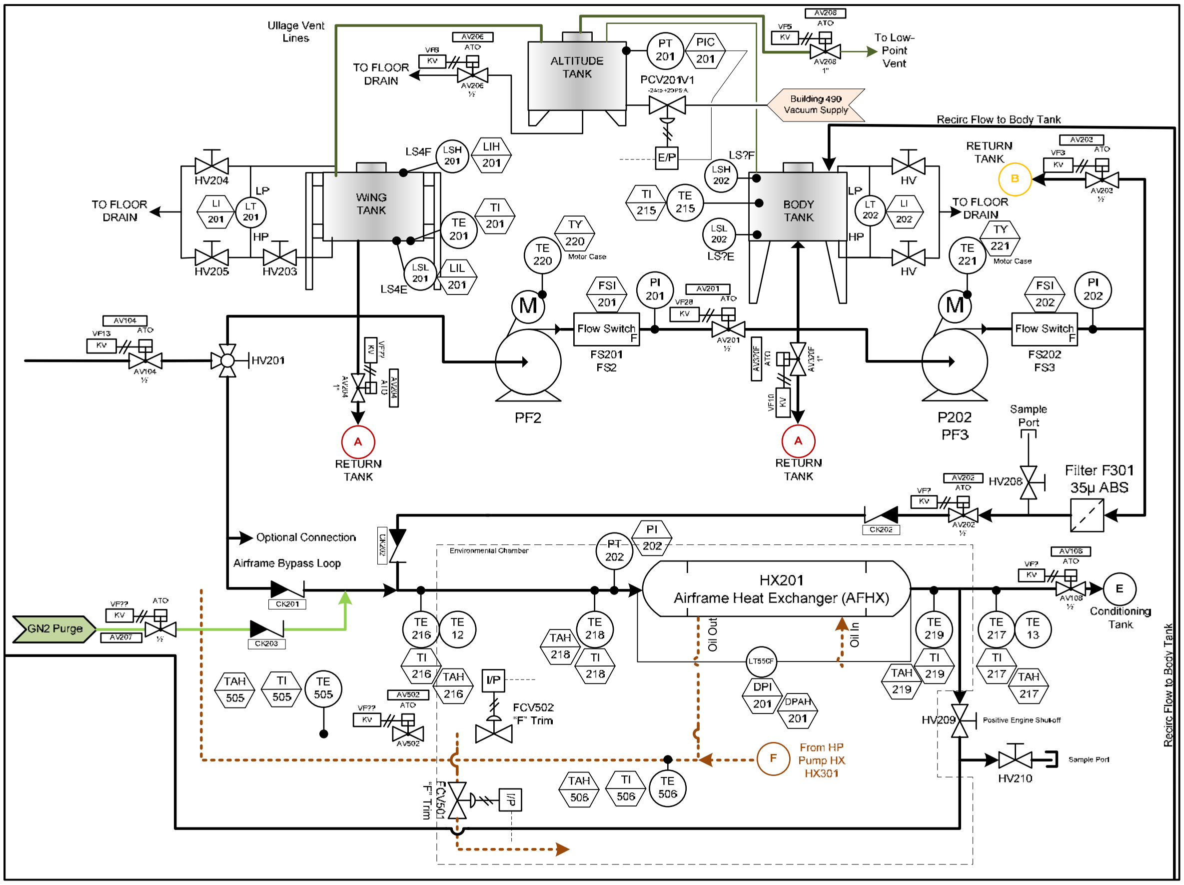


Figure C - 9 Process Diagram for Wing and Body Tanks

Airframe Heat Exchanger (AFHX)

While the heat loads associated with an aircraft engine are responsible for the bulk of the heat loading experienced by the fuel, the airframe contribution to this overall heat load is not insignificant. Heat loads from cooling of electronics, weaponry and environmental control systems can be substantial. The original design of the FSS included accommodations for heat loads generated by the Environmental Control System (ECS), Airframe-Mounted Accessory Drive (AMAD), Avionics Systems, Integrated Drive Generator (IDG), Hydraulics Systems[2] (Power Control 1[PC1], Power control 2 [PC2] and Utilities), weapons systems, etc.

For the FSS, all head loads from airframe sources are lumped together and burdened to the fuel through the AFHX contained in a portion of the Airframe Fuel System Simulator designated the Environmental Chamber (so designated because it is a nitrogen-inerted environment inside the chamber). The heat source for the AFHX is oil from a Chromalux Model COHT-18 heating unit[3]. Figure C - 10 shows a PID of the Airframe Heat Exchanger and Figure C - 11 shows the Environmental Chamber containing the Airframe Heat Exchanger (wrapped with insulation, far right inside the chamber).

[2]"Power Control 1 (PC-1), Power Control 2 (PC-2)"… "systems power the primary flight controls and the Utility System supplies all other requirements, plus back-up for stabilator longitudinal and roll control, aileron roll control, and rudder directional control. Hydraulic power is available to adequately and safely maintain control for flight and landing with any one of the three systems operational."
(http://www.f15sim.com/operation/f15_hydraulic_system.html, "F-15 Hydraulic System", ROBERT S. ANDREWS, Senior Engineer, Hydraulic Design)

[3] The Chromalux unit provides hot oil as a heat source for all oil-heat-based heaters for the FSS.

Altitude Control Subsystem

For various reasons, aircraft maintain a pressurization schedule in aircraft fuel tanks. In some cases, where fuel volatility may be an issue at high altitude sub-atmospheric pressures, a positive tank pressurization schedule helps prevent fuel loss due to boiling. To simulate this effect, the FSS configuration includes an Altitude Tank (AT) that has connections to the ullage spaces of all other system tanks. Therefore, by establishing a pressure or pressurization schedule in the AT, that same condition is established in all tanks. Facility vacuum is used by the control system to maintain the appropriate pressure. As with other controllable parameters, this pressure can be controlled as a function of mission condition. While this capability exists in the current FSS configuration, it is not typically used and virtually all FSS missions are accomplished at 'ground level altitude" conditions (Dayton, Ohio).

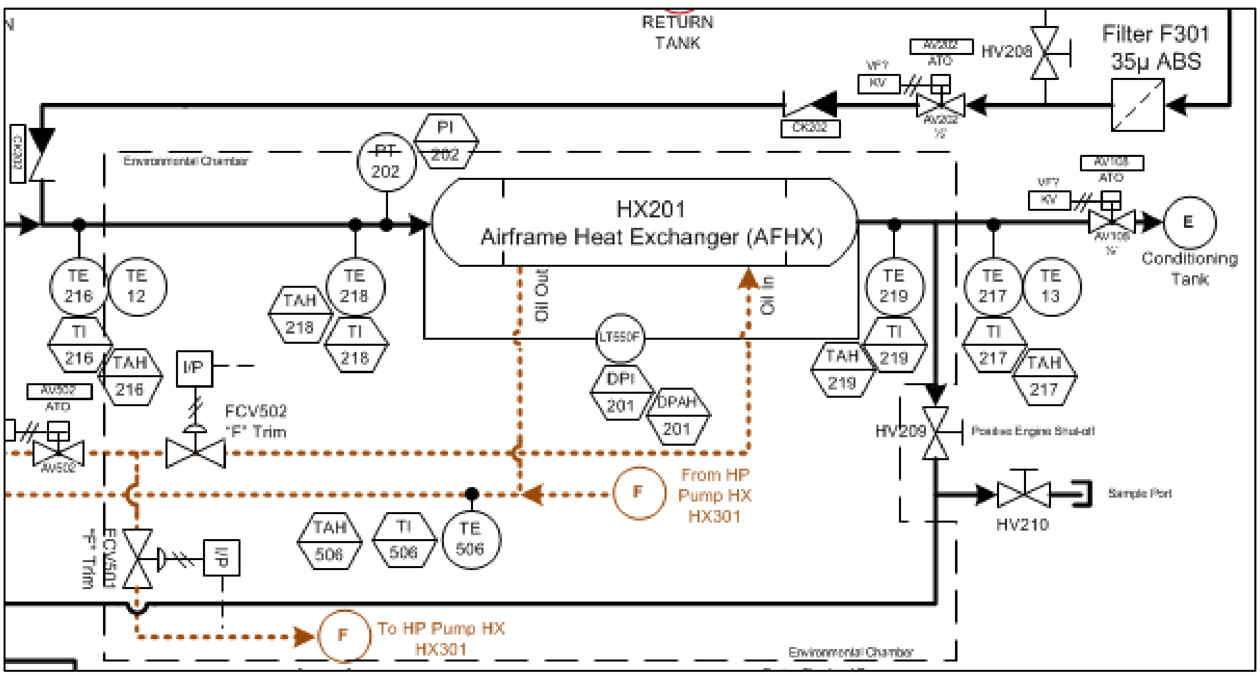


Figure C - 10 Airframe Heat Exchanger

Figure C - 11 Environmental Chamber with Airframe Heat Exchanger

Engine Fuel System Simulator

The remaining major elements of the FSS are all encompassed in the Engine Fuel System Simulator subsystem. A front view of the Engine Simulator cabinet is shown in Figure C - 12. In Figure C - 12, the upper section is where all of the simulated engine components reside. The lower section houses the RF Induction Heaters used to inductively heat the Fuel-Cooled Oil Cooler (FCOC) and the Burner Feed Arm (BFA).

The Engine Fuel System subsystem consists of several major components. Data obtained from these components comprises the bulk of the data obtained from the FSS. These major components include the High Pressure (HP) Pump (and an associated heat exchanger, the HP Pump Heat Exchanger (HPHX), the Fuel-Cooled Oil Cooler (FCOC), a Servo Valve (SV)-controlled fuel recirculation loop, the Torque Motor Screen (TMS), the Flow Divider valve (FDV), the Burner Feed Arm (BFA) and a Nozzle Screen Simulator (NSS). The overall scale of the FSS is 1/72nd scale of a full-scale aircraft. This is based upon the FSS containing one nozzle out of 24 nozzles in the actual engine with flow rates in this nozzle being 1/3rd of the full engine flow in that nozzle. Each of these individual components is describe later in this section.

Due to the high likelihood of potential fuel leaks in the Engine Simulator, the entire cabinet if purged with nitrogen. Oxygen sensors monitor for the correct amount of purging inside the cabinet. Anything below 1% oxygen is considered normal operation. Warning alarms occur when oxygen levels reach 3% and shutdown procedures are initiated when oxygen levels reach 5%. Since this system is fully enclosed for purging, a water-cooled radiator and fan are included inside the cabinet to prevent the interior of the cabinet from getting too warm and skewing the simulation and potentially damaging electronic control system components vital to data acquisition and safe control.

Boost Pump, High Pressure Pump, Filter and Heat Exchanger

In nearly all aircraft applications, fuel flow and pressure are provided and maintained by the action of two pumps – a Boost Pump and a High Pressure Pump. The Boost pump, for the purposes of this FSS rig, is considered an Airframe component. It provides pressurized fuel to the inlet of the High Pressure Pump, which is typically a positive displacement gear pump. Fuel pressure at the inlet side of the HP Pump must be kept above 35 psig in order to prevent cavitation on the suction side of the HP Pump. This cavitation must be prevented in order to prevent damage to the HP Pump and maintain a valid simulation.

For the FSS, the Boost Pump function is served by the centrifugal pump feeding fuel from the Body Tank to the Environmental Chamber. Hence, as in typical aircraft, this pump is actually an aircraft airframe asset. The centrifugal pump in the FSS is a (Oberdorfer Model 800 – aluminum housing) and is capable of providing fuel pressures up to about 60 psig. In the FSS implementation, a bypass loop is installed from the exit of the Boost Pump back to the Body Tank so that the inlet of the HP Pump is not over-pressurized during operation.

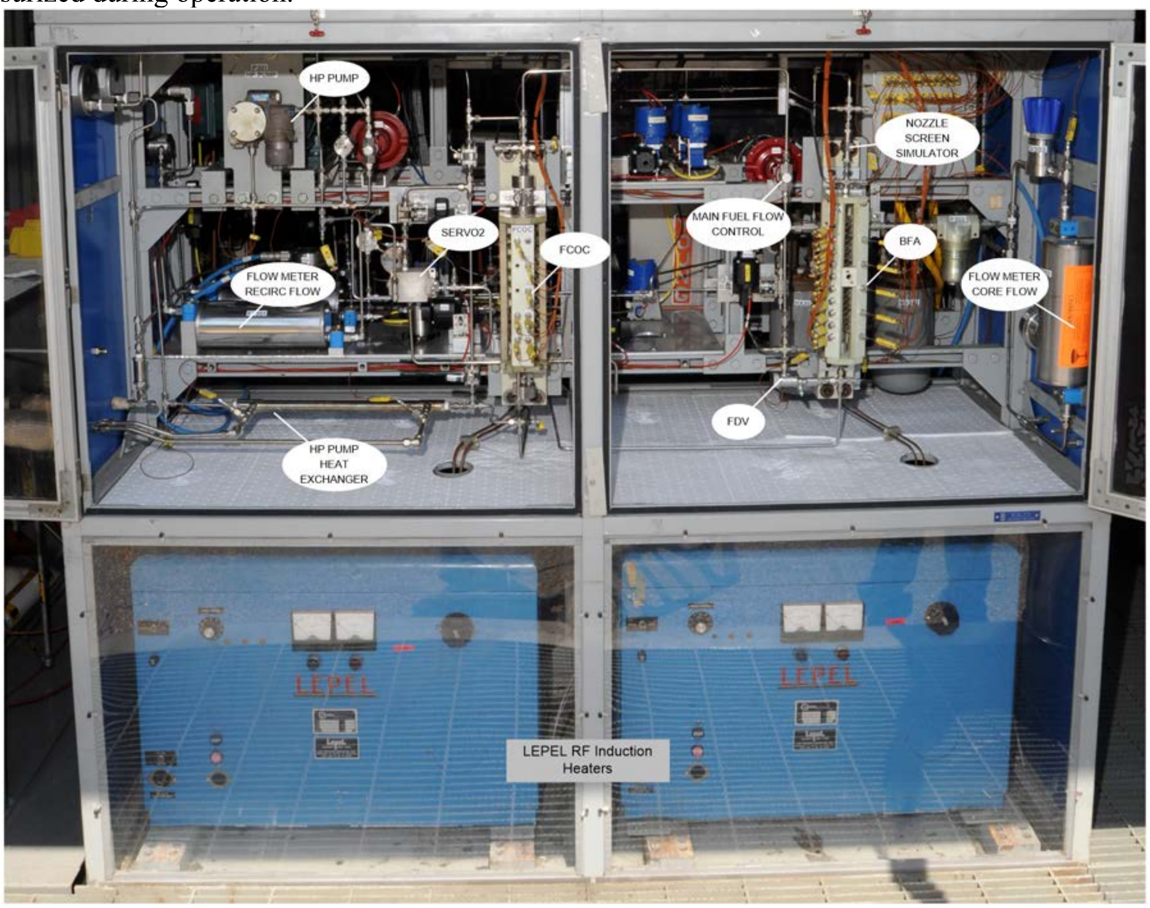


Figure C - 12 Engine Simulator Cabinet, Component Layout

The HP Pump, as originally designed and installed in the FSS, was a specially modified Sundstrand/Pesco Rotary Gear Pump Model 025323-101 commonly used for the engine of the executive jet PT6 as well as other aircraft. It was chosen for its small size and the ability to generate high pressures at low flows. The FSS is currently using a new version of the original pump now manufactured by Sundstrand as Model Number 025323-101-03 (Figure C - 13). It is designed to deliver fuel at pressures from 75 to 800 psig and is driven by an electric motor that runs at up to 3450 RPM. Normally the pump draws fuel into the IN port, through the 74 micron inlet filter, and forces it out of the OUT port through the 10 micron paper filter. However, if the pressure differential across the inlet filter increases above a preset value due to

filter restriction, the filter will lift from its seat, allowing the fuel to bypass the filter. Restriction of the discharged filter will cause the discharge filter bypass valve to open at a preset value. The bypass pressure regulating valve maintains bypass fuel pressure at 10 to 35 psig above the inlet pressure. While this filter was originally intended as just a system filter, it has now been found to provide valuable qualitative data so it is replaced for each new Run. Pictures of this filter are captured and used in assessing the overall results of the Run.

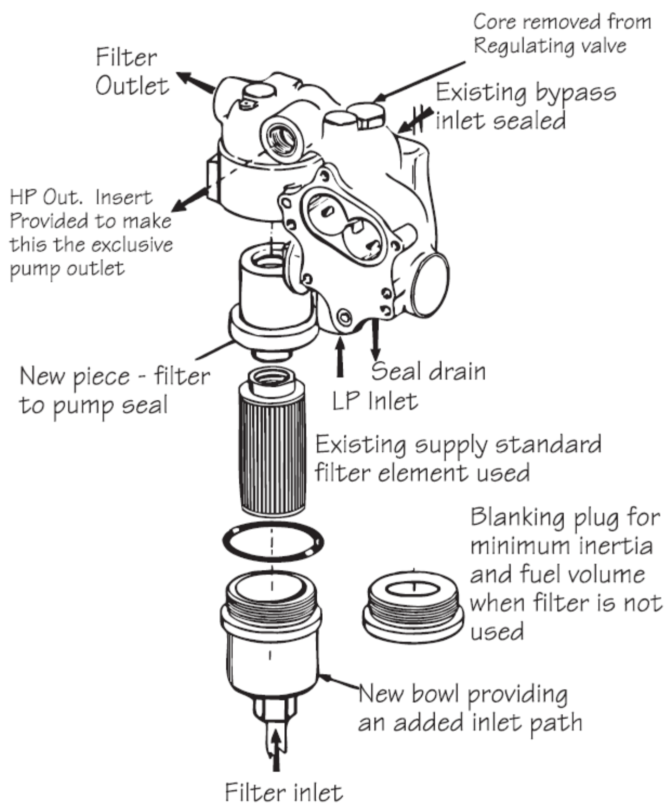


Figure C - 13 HP Pump Assembly

The estimated mass of the HP Pump, being mostly aluminum, is a little over 4 pounds. This means that the ratio of the thermal mass of the pump to the fuel thermal mass at FSS rig scaled flow rates is out of balance with real-world conditions. As a result, even under low flow, high pump rpm operation, the fuel typically cools down as it flows through the pump. In the real world, since gear pumps are tied to engine rpm, the pump can operate providing as much as 13 times the needed capacity for the aircraft. Since the pump is a positive displacement pump, this means that the unusable excess flow capacity has to be bypassed around the pump. The net effect is that in the real-world application, the pump 'works' the fuel resulting in a significant temperature rise in the fuel from inlet to outlet. Such is not the case at FSS rig scales. But since fuel time/temperature history is critical in these simulations, it is critical to not allow fuel temperature to reduce through this pump. This has been accomplished by installing a heat exchanger (HP Pump Heat Exchanger, HPHX) immediately downstream of the HP Pump. Figure C - 14 shows the HP Pump as installed in the FSS.

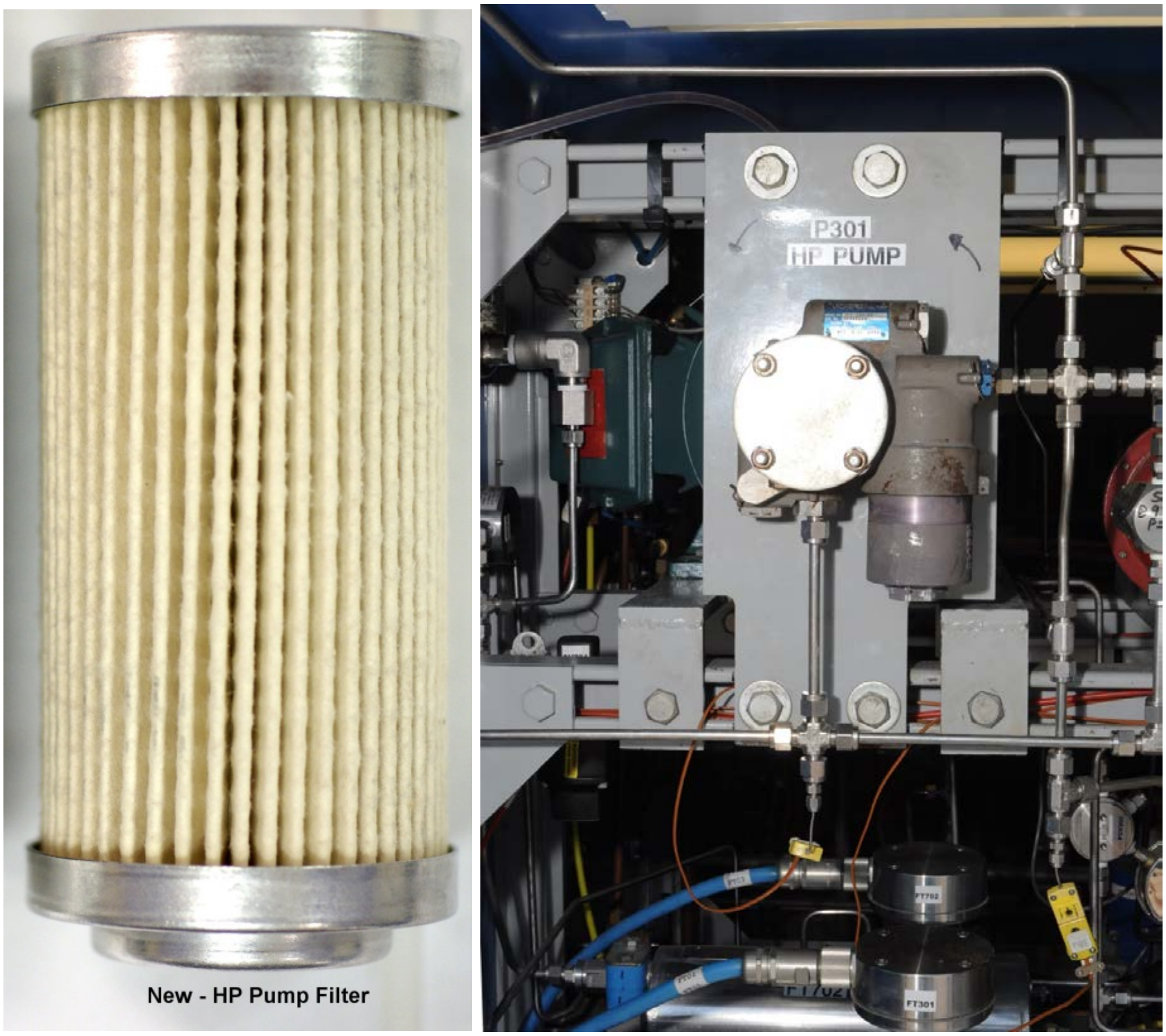


Figure C - 14 HP Pump Filter (left) and HP Pump As Installed (right)

Fuel-Cooled Oil Cooler (FCOC)

One of the main thermal management uses of fuel on-board an aircraft is for cooling engine oil. In most systems, this involves simply exchanging heat between the engine oil and the fuel in a simple heat exchanger device – a Fuel-Cooled Oil Cooler (FCOC). The FCOC is based on a shell-and-tube heat exchanger design where fuel passes through the exchanger on one side of the tube and engine lubrication oil passes on the other side. The number of tubes used in the FCOC depends upon the engine design and the amount of heat dissipation required. Normally, accepted engine design criteria dictates that bulk fuel temperature out of the FCOC should never exceed 325 °F (163 °C) which is the limit for oil operability in the engine. Obviously, at these temperatures, fuel can foul and coke can be deposited on the inside of the tubes of the FCOC. As with any heat exchanger, any fouling, either on the inside or the outside of the tubes, is detrimental to FCOC performance and can result in engine oil temperatures exceeding design limits.

The FCOC has been developed to give efficient heat transfer to the fuel thereby allowing the FCOC to operate at the lowest possible wetted surface temperatures. This design is optimized for heat transfer and

contains four end-to-end passes. Internal mixers are installed in the first two passes to maximize fuel flow turbulence to enhance heat transfer. Figure C - 15 shows a partial PID of how the FCOC fits in the FSS. Figure C - 16 shows a rendering of how the FCOC is constructed.

The FCOC is not a test article in and of itself. Instead either a tube or a filter screen (230-micron nominal) is installed at the FCOC fuel exit to monitor for bulk fuel deposition.

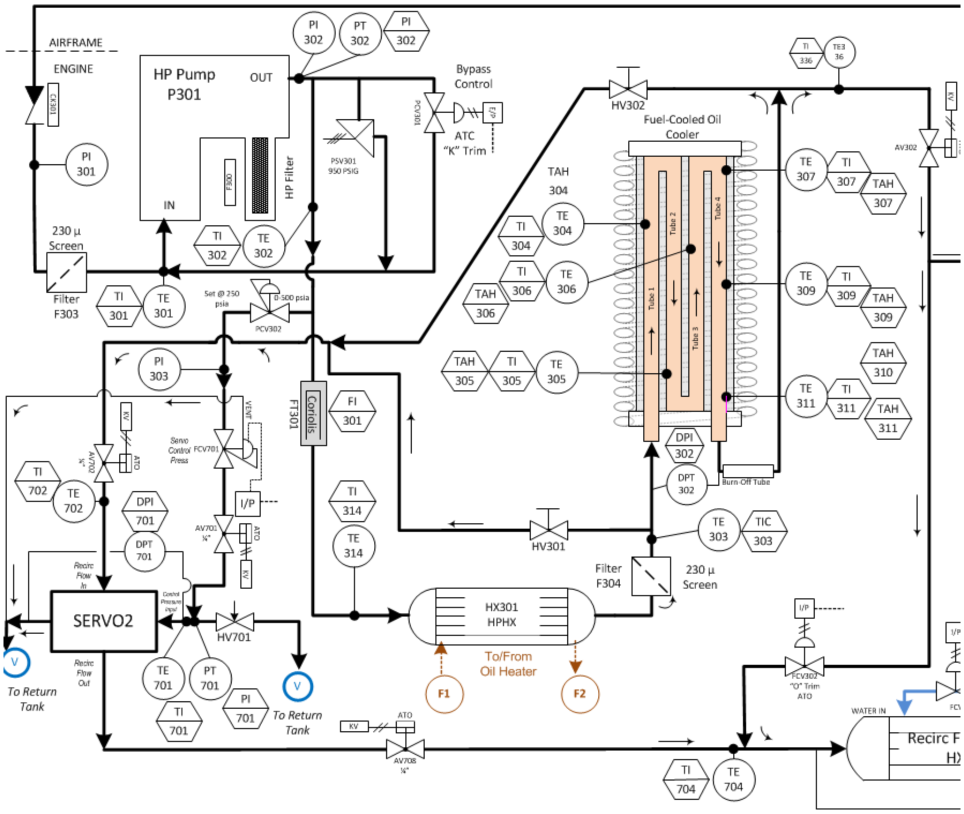


Figure C - 15 Fuel Cooled Oil Cooler PID

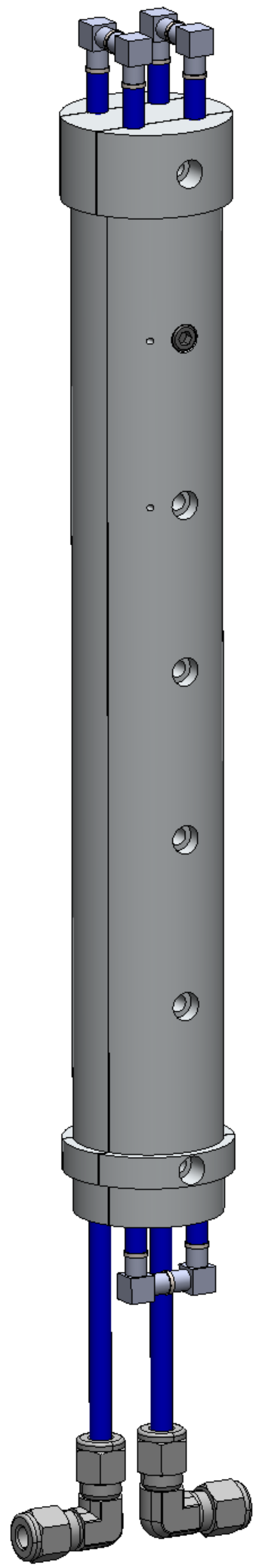


Figure C - 16 3-D Rendering of FCOC

Servo Valve

Throughout most aircraft systems, control valves are used to control various functions of the aircraft airframe or engine systems. These valves are called Electro-Hydraulic Servo Valves (EHSV) and they can serve many different control functions. For the FSS, the Servo Valve (SV) component is the second stage or hydraulic portion of an EHSV. The EHSV used in the FSS is real engine hardware that has been modified to work at the FSS scale. This particular valve has a diametrical clearance of 0.00010 – 0.00020 inches and a total stroke of +/- 0.032 inches from fully open to fully closed. Figure C - 17 shows the Servo Valve assembly including the housing block, the spool and the sleeve.

Many of these servo valves use fuel as a hydraulic fluid for actuation. Depending upon the location of the valve in the system and the source of the fuel supply, these valves can operate at temperatures where bulk fuel deposition can take place. Since the ability of the EHSV to operate is dependent upon the unrestricted movement of the spool and sleeve valves that make up the hydraulic portion of the valve, even the slightest amount of deposition occurring in this valve can impact valve performance by causing hysteresis in the valve. Under the best of circumstances, a well-designed and well-functioning control valve has little or no hysteresis thereby allowing the control algorithms that predict and impose control movements to reliably and predictably position the valve for stable system control. As hysteresis increases, control algorithms may not properly compensate and system control can become unstable.

In addition to this valve serving as a test article in the FSS, it also serves to control the bypass fuel flow from the engine back to the body tank in the same way that high performance fighter aircraft recirculate fuel from the engine the airframe tanks for fuel thermal management.

For all FSS testing, SV hysteresis is measure pre- and post-test and is defined by relating differential pressure (DP) across the SV to flow rate (F) through the valve. These measurements are made on the SV while it is installed in the FSS both pre-test and post-test.

In addition to the hysteresis measurements made on the Servo Valve, at the end of each test run the Servo Valve is disassembled and photographed to document the amount and nature of the fuel deposits inside and on the valve components. This deposition, along with Servo Valve hysteresis measurements, documents the condition of the valve at the end of each test. The very nature of the EHSV tends to minimize the impact of hysteresis naturally so no firm value for hysteresis in this component has been established as an acceptable amount. Instead, SV performance is generally evaluated as a ‘do no harm’ criteria. Post-test SV hysteresis behavior is determined generally to be acceptable as long as the hysteresis is not significantly different from pre-test measurements. This causes the data obtained on the SV performance to be somewhat subjective rather than analytical.

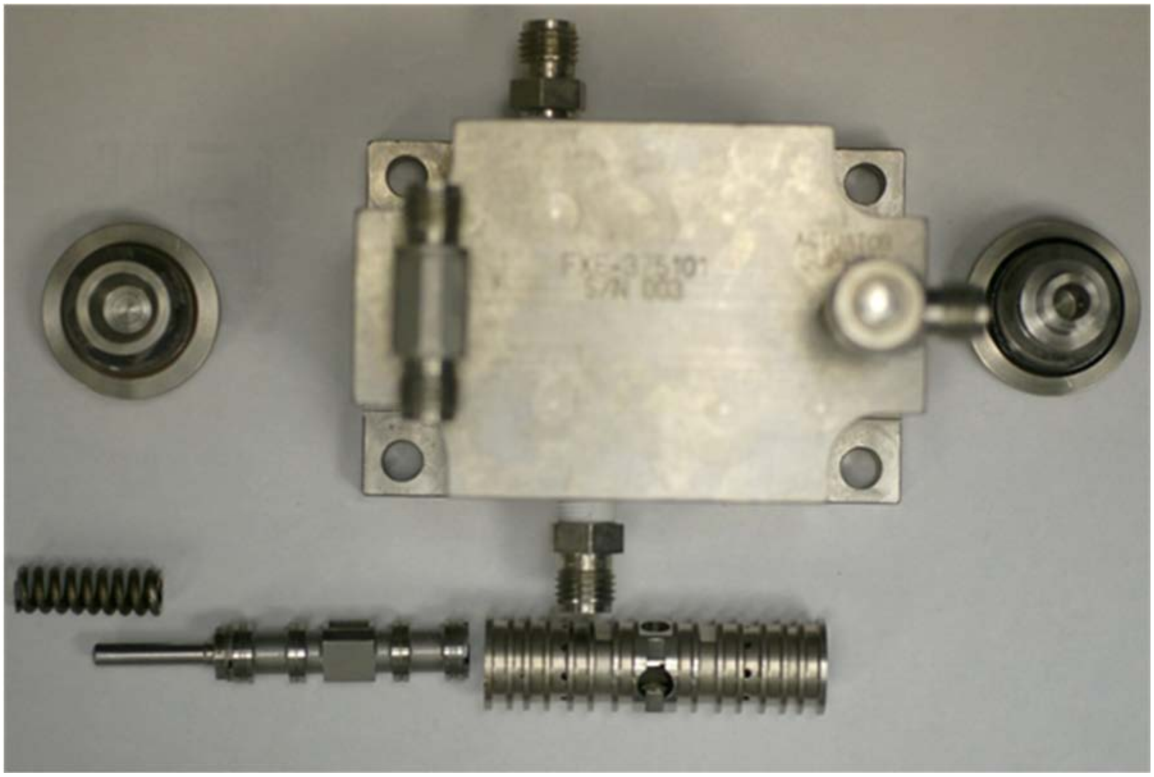


Figure C - 17 SV Assembly Showing the Body, End Caps, Spool and Sleeve

Servo Valve Hysteresis Ratings – Subjective Definitions

Servo Valves operate on a fundamental principle that increasing or decreasing the pressure to the valve control increases or decreases fuel flow through the valve – depending on whether the valve acts as a 'normally open' or 'normally closed' valve. In an ideal valve, the flow vs. pressure curves for control pressure increasing and flow control pressure decreasing would lay one on top of another indicating that no matter which direction the valve is moving, the flow will be the same for a given control pressure. However, this ideal valve does not exist and every valve exhibits some measure of hysteresis.

The first indication of hysteresis is the spread of the control pressure increasing/decreasing curves (how far apart these curves are from one another). The wider the spread, the greater the hysteresis. Secondly, as hysteresis comes into effect, the curves can not only just spread apart but the endpoints of the curves can shift either up/down or left fight. If the entire hysteresis curve moves up or down, this is referred to as 'shift'. If the entire hysteresis curve shifts left/right, this is referred to as 'skew'. Hysteresis for a particular valve can therefore be described in these terms – spread, shift and skew. Since for any given hysteresis characteristic for a valve, the shift and skew values may behave independently from one another, making it difficult to simply characterize the hysteresis condition for a valve for cross-comparison. Because of this, a set of subjective descriptions have been developed to try to provide a simple comparison basis for hysteresis in these valves.

Generally these subjective 'standardized' descriptions are as follows:

- **NONE:** indicating that the pre-test and post-test hysteresis curves, for all intents and purposes, are nearly indistinguishable from one another. Minor differences may be seen between the pre-test and post-test curves but these are very small.
- **Minor:** There are small differences between per- and post-test curves. The spread for these curves is typically within 5% of one another. There may be some small changes in shift and skew

for the valve. This degree of hysteresis would not be expected to alter the functional nature of the valve.

- **Moderate:** There are definite differences between pre-and post-test curves. There may be definite differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically between 5% and 15%. This degree of hysteresis might be expected to alter the functional nature of the valve.
- **Severe:** There are pronounce differences between pre-and post-test curves. There may be pronounced differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically in excess 15%. This degree of hysteresis would be considered out-of-spec for the valve.
- **Non-Functional:** There are major differences between pre-and post-test curves. There may be major differences in shift and skew as well. The hysteresis curve will exhibit flat segments (either vertically or horizontally). Shift and skew have majorly changed the performance envelope of the valve. This degree of hysteresis would cause the valve to be non-functional or unresponsive over small or large portions of the performance range of the valve.

Recently, a less subjective and more analytical approach has been developed to provide a measurement for hysteresis. This new method involves calculating the area between the hysteresis curve envelope lines. Pre- and post-test calculations are made and a differential area is calculated by difference and this area count is related to hysteresis – the larger the area count, the greater the hysteresis.

Torque Motor Screen (TMS) and Filter Strainers

The Torque Motor Screen (TMS) (Figure C - 18) is a recent addition to the FSS and was not included in the original design of the FSS. In many systems, there exists course screen filters upstream of critical components whose sole purpose is to protect the upstream device from large debris in the fuel flow. This has been an important component in the Aircraft Fuel Thermal Stability Test Unit (AFTSTU) that has been operated by Rolls Royce (UK) and the University of Sheffield (UK) and has proven to provide valuable simulation data relating fuel thermal stability in an aircraft engine. In 2014, University of Sheffield shared their design with AFRL and the TMS device was added to the FSS. The TMS consists of an off-the-shelf screen manufactured by Pall Aerospace as a Fluid Filtering Disk, Part Number 20020-250-70.

Figure C - 18 TMS Exploded View

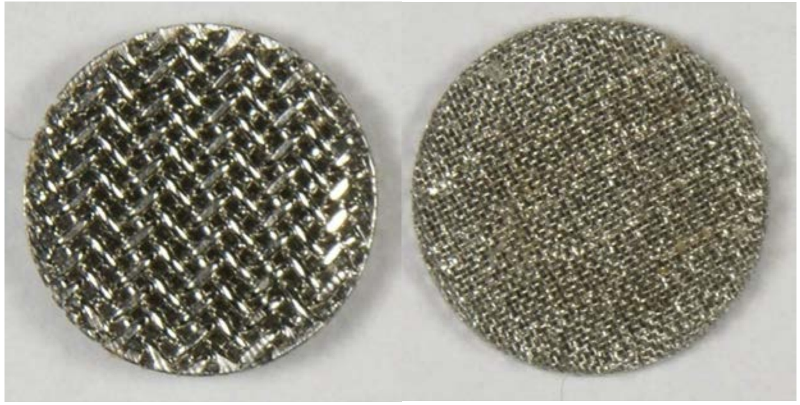


Figure C - 19 Torque Motor Screen Top (left) and Bottom (Right)

Recently, due to the valuable information gathered from use of the TMS module, four additional screen-type devices have been added to monitor bulk fuel deposition. F303 (filter/strainer) is mounted in the main fuel flow upstream of the HP Pump and is a Swagelok™ ½-inch SS-8TF - Tee-Type Filter Housing with a 316 SS SS-8F-K4-230 Filter Strainer. F304 is mounted downstream of the HP Pump Heat Exchanger and is a Swagelok™ ¼-inch SS-4TF - Tee-Type Filter Housing with a 316 SS SS-4F-K4-230 Filter Strainer. Both filter strainers are 230 micron. These two filter strainers are in locations that experience different bulk fuel temperatures with F303 being in the lowest temperature environment and F304 being in a slightly higher temperature environment. The third filter/strainer is F305 and is mounted in the bulk fuel flow at the FCOC fuel outlet upstream of both the SV and the TMS. It a Swagelok™ ½-inch SS-8TF - Tee-Type Filter Housing with a 316 SS SS-8F-K4-140 Filter Strainer. F305 is mounted in the second highest bulk fuel temperature area of the FSS. F702 is the fourth filter/strainer and it is mounted in the recirculated bulk fuel flow out of the SV. It is placed after the Air Cooled Fuel Cooler and is therefore subject to potentially higher deposition as deposits 'precipitate out' of the fuel as it cools. It is a Swagelok™ ½-inch SS-8TF - Tee-Type Filter Housing with a 316 SS SS-8F-K4-230 Filter Strainer. Since these strainers have a similar function to the TMS, they are analyzed post-Run in the same way as the TMS. Having these screen-type devices in different bulk fuel temperature zones allows examination of bulk fuel deposition characteristics based on different temperature regimes.

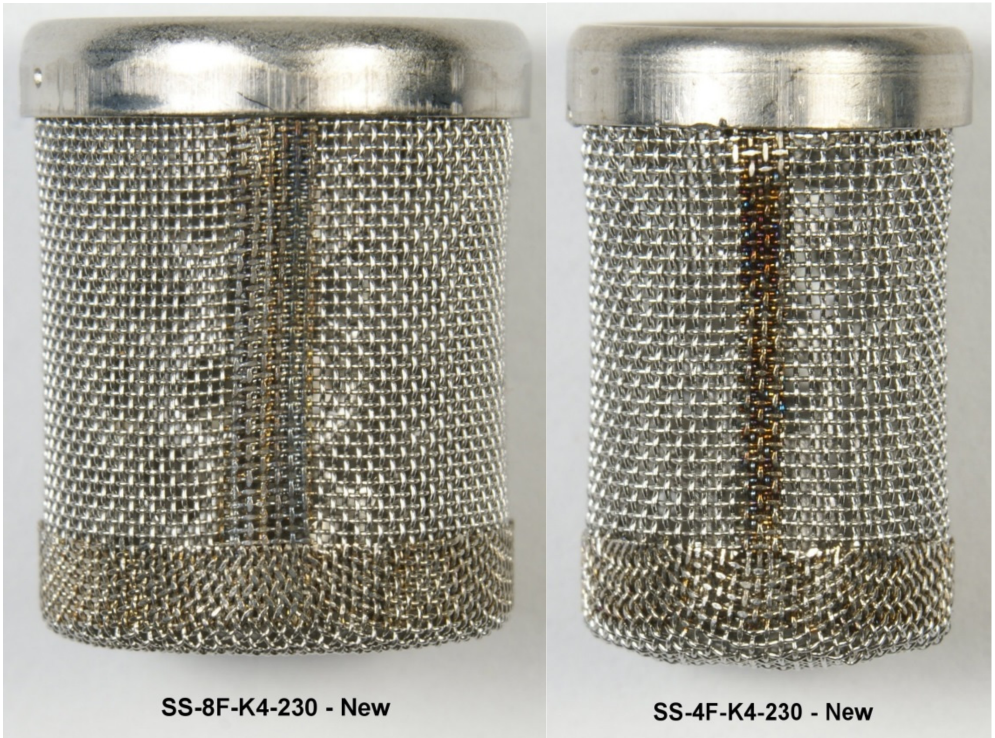


Figure C - 20 230µ Screens for F303, F304 and F702

Flow Divider Valve (FDV)

The next component of the FSS immediately downstream of the TMS is the Flow Divider Valve (FDV) or sometimes referred to as the Flow Diverter Valve.

In the engine, this valve is physically positioned upstream of the fuel nozzle face and is located outside of the combustor itself in the compressor bypass or fan air flow path. Since this air flow can reach temperatures in excess of 400 °F, the FDV is subject to coking. As with any other valve that is used to regulate flow, any coking or fouling of the FDV can result in significant valve hysteresis – which can in turn significantly alter fuel flow characteristics and affect the combustor radial temperature profile as well as the critical Turbine Inlet Temperature profile. Adverse changes in this profile can have profound adverse effects on engine hardware.

In the FSS, an actual FDV from a P&W F119 engine is used. The flow slot has been modified by narrowing its width so that the typical stroke of the valve in the FSS' reduced flow environment is essentially the same as for the full flow in the engine. Figure C - 21 shows the various components of the FDV as well as an assembly view of the FDV itself. It should also be noted that in the FSS, this valve is not actively heated as it would be in the engine.

Figure C - 21 Flow Divider Valve Components and Assembly

The normal acceptability criteria for FDV hysteresis would be 7% or less. According to P& W design engineers, hysteresis values beyond 7% could adversely impact the fuel flow to the nozzles and thus change the combustor temperature profile in the engine. An altered combustor temperature profile can have serious and deleterious impact on engine performance, reliability and safety.

Hysteresis measurements on the FDV are determined in much the same way as for the SV. As with the SV, a set of subjective descriptions have been developed to try to provide a simple comparison basis for hysteresis in these valves. As with the SV, these standardized descriptions are as follows:

- **NONE:** indicating that the pre-test and post-test hysteresis curves, for all intents and purposes, are nearly indistinguishable from one another. Minor differences may be seen between the pre-test and post-test curves but these are very small.
- **Minor:** There are small differences between pre- and post-test curves. The spread for these curves is typically within 5% of one another. There may be some small changes in shift and skew for the valve. This degree of hysteresis would not be expected to alter the functional nature of the valve.
- **Moderate:** There are definite differences between pre-and post-test curves. There may be definite differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically between 5% and 15%. This degree of hysteresis might be expected to alter the functional nature of the valve.
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Recently, a less subjective and more analytical approach has been developed to provide a measurement for hysteresis. This new method involves calculating the area between the hysteresis curve envelope lines. Pre- and post-test calculations are made and a differential area is calculated by difference and this area count is related to hysteresis – the larger the area count, the greater the hysteresis.

As with the Servo Valve, in addition to determining FDV valve hysteresis, the FDV is disassembled and photographed at the end of each FSS run to document the degree and nature of the deposition that occurred in and on the valve components. These components include the FDV valve body, valve stem and strainer screen that surrounds the entire assembled valve and protects it from large pieces of debris.

Burner Feed Arm (BFA)

In the engine that was used as a model for the FSS, each combustor nozzle is made up of an assembly of three components – the FDV (which was discussed in a previous Section), the tubular pathways connecting the FDV to the nozzle (often referred to as the 'Burner Feed Arm' (BFA)) and the nozzle itself. In the actual nozzle assembly, the BFA portion of the nozzle assembly is subjected to high temperature compressor discharge air so these flow tubes are contained within a complex shroud assembly designed for thermal isolation and protection. The performance of the combustor fuel nozzle is critical to engine performance and control. This performance and control is not only impacted by the performance of the FDV in each combustor nozzle assembly, but it is impacted by the ability of the BFA flow tubes to deliver unrestricted fuel flow to the nozzle. Even though these tubes are shrouded for thermal protection, significant coke deposits can develop inside these tubes which can restrict fuel flow to the nozzle and therefore impact nozzle assembly overall performance. Figure C - 22 shows a portion of the FSS PID that shows the arrangement of the TMS, FDV and BFA as well as the instrumentation for these devices.

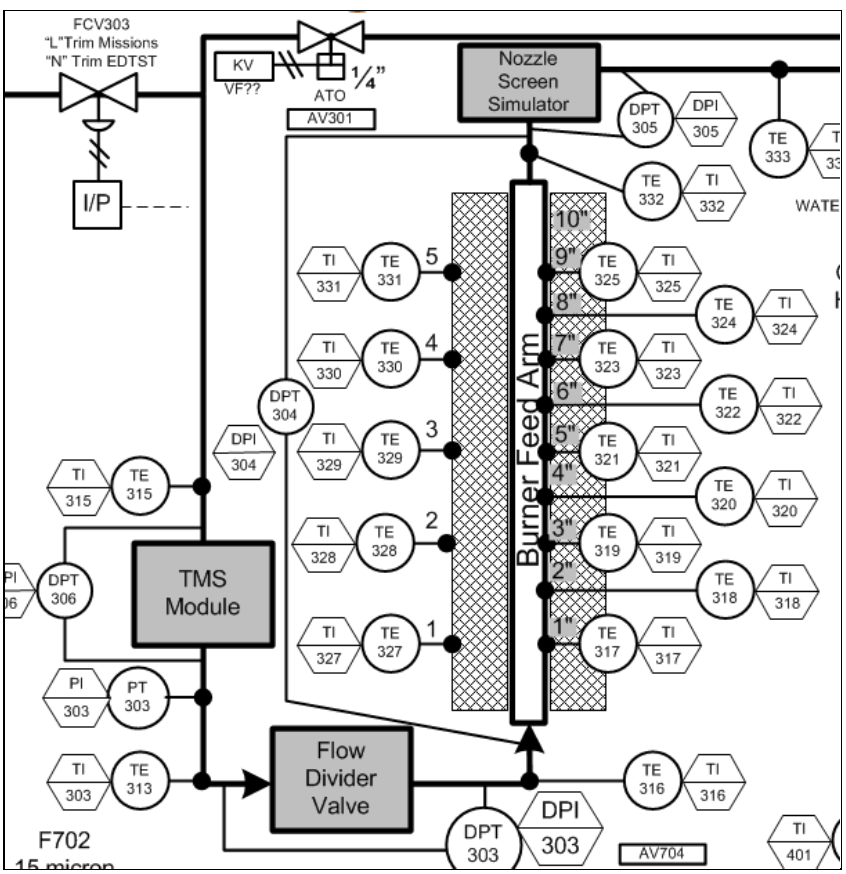

Figure C - 22 Partial PID Showing TMS, FCOC, BFA and NSS

The BFA is constructed of two pieces. The first piece, the test article tube, is a 316 stainless steel tube 0.125 inches O.D, 0.085 inches I.D. with a 0.020 inch wall cut to 14.25 inches in length. The inside of the tube is electro-polished for a uniform surface. This test article tube is placed inside a clamshell of 316 stainless steel that is 0.5 inches overall diameter and cut to 13.25 inches long. The clamshell is split in half so that is bolted around the test article tube. The clamshell is drilled through with ten holes for thermocouple placement. Thermocouples are inserted through the clamshell to touch the external wall of the test article tube, providing measurement of the approximate internal fuel-wetted wall temperature along the test article tube. The clamshell is also prepared with divots on its external surface along its length providing 'seats' for thermocouples to measure the external surface temperature of the clamshell itself. These thermocouples are installed via spring-loaded thermocouple holders that apply pressure to keep the thermocouple in direct contact with the clamshell surface inside the divot. Only five thermocouples are used even though there are 10 divots available.

The test article tube is placed inside the clamshell with about 2-1/8 inch exposed at the fuel inlet and 2-1/8 inches exposed at the fuel outlet. These extension sections allow assembly of the BFA assembly into the FSS rig. A heat-conducting silicone compound is used to assure good thermal contact between the clamshell and the test article tube. The clamshell is then assembled around the test article tube with 5 pairs of screws assuring both good thermal contact between test article tube and the clamshell and rigid construction of the test article assembly. Once assembled, the BFA assembly is mounted vertically in a specially designed holder for the test. During the test, fuel flows into the bottom and out the top of the BFA assembly. RF heating is applied to the assembly to heat it. Figure C - 23 shows how the BFA is mounted in its holder in the FSS as well as the thermocouple placements.

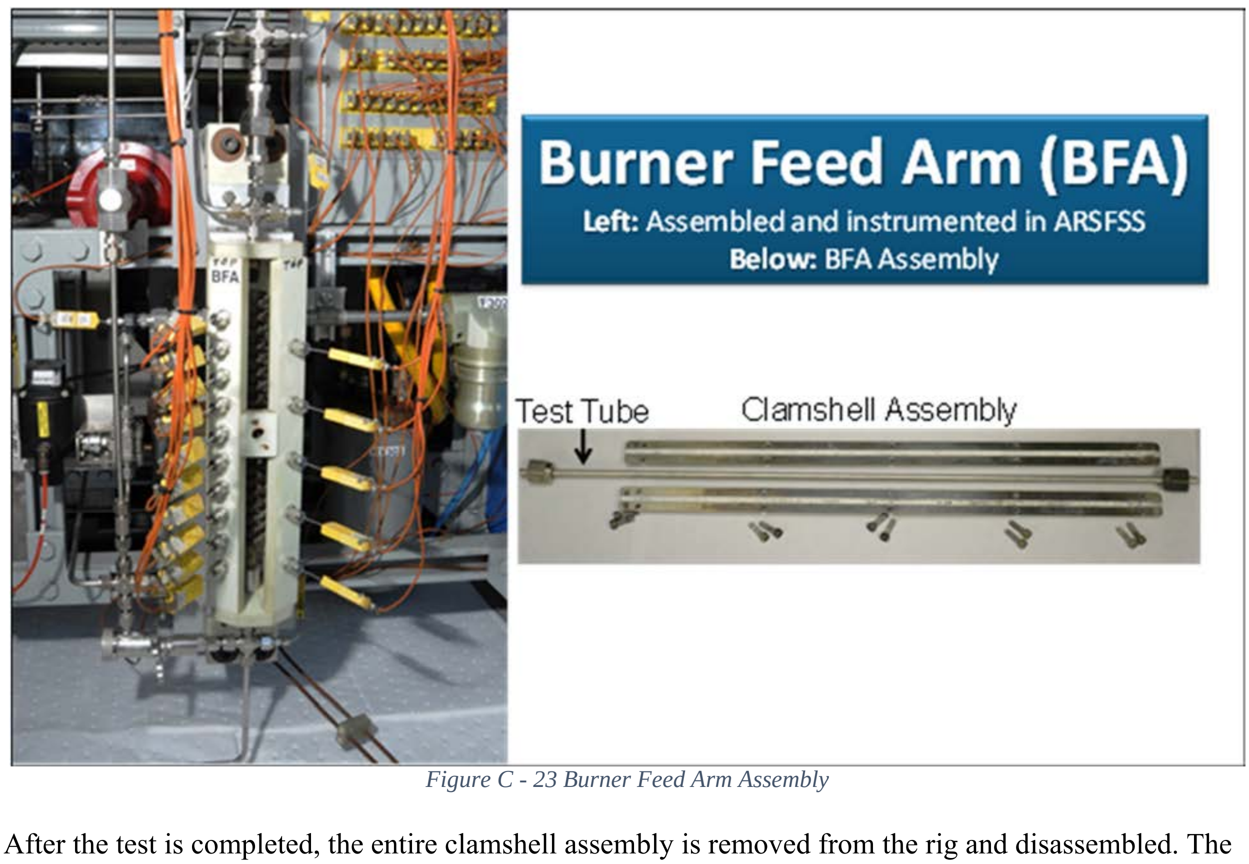

Figure C - 23 Burner Feed Arm Assembly

After the test is completed, the entire clamshell assembly is removed from the rig and disassembled. The 2-1/8-inch extended mounting sections are cut off of the test article tube and discarded. Any residual thermal heat sink compound is removed from the external of the test article tube. The test article is then

cut into ten 1-inch sections. Each section is gently rinsed with hexane to remove any remaining liquid fuel residue and then dried overnight in a vacuum oven at 110 °F. Once these sections are dried, they are subjected to destructive carbon analysis by LECO Carbon Analyzer. In addition to the burn-off of the run samples, standardized clean samples of tube taken from the same lot of tubes used to make the BFA test article and subjected to burn-off to establish a nominal background carbon level. Burn-off samples from the run are corrected for this standard background level and the calculation becomes the Effective Carbon measurement.

Nozzle Jet Screen Simulator Module

The Nozzle Jet Screen Simulator (NSS) represents the last simulated device in the FSS. This device simulates the small orifices and screens that are part of or surround many combustor nozzles. These screens are meant to protect the fuel nozzle orifices from debris but they can partially plug due to the fouling nature of the fuel. Not only is the fuel in this area very hot (bulk fuel temperature in excess of 350 °F) but the face of the screen is subjected to the back-radiation from the combustor flame front. The net result is an area where fuel deposits are likely to form. Figure C - 24 shows the actual hardware. The NSS consists of a housing and an internal holder which contains at least one Lee Company safety screen (http://www.theleeco.com/). The NSS is designed to accommodate a series of screens. Etched screen part numbers are FSJA1300040A, FSJA1300060A, and FSJA1300080A. Drilled screen part numbers are FSJA1301150A and FSJA1301200A. The screen normally used is the drilled screen part number FSJA1301200A. This screen is has twenty-seven 0.020-inch (0.5 mm) holes. Normally, just one screen is used in testing. The hole for the second screen is normally plugged with a blank.

Post-test, this test article is photographed and compared with clean hardware to make a qualitative determination of fuel deposition. No carbon burn-off analysis is performed on this article.

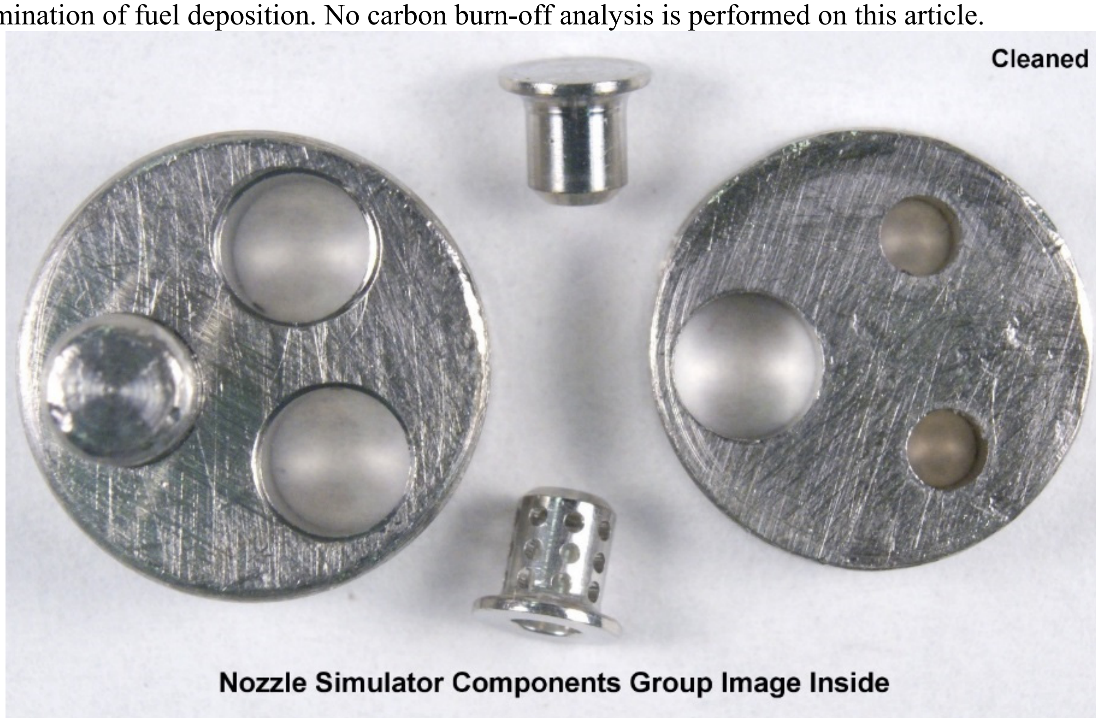

Figure C - 24 Internal Components, Nozzle Jet Screen Simulator

Data Collection and Calculations:

The iFIX collects data and status information from the over 400 I/O points on the system every second. Using specific data extraction software and Microsoft Excel, data is collected and analyzed at the end of each Run. A standardized Excel spreadsheet has been developed for this analysis capability and the

spreadsheet tabulates and charts the appropriate data nearly automatically making data reduction and analysis simple.

System Safety

Alarms, Faults and Failures

Safe operation of the FSS is of paramount importance in order to protect operations personnel, the facility and the FSS rig itself as well as the data integrity of the test programs. Over the course of time, the control system has been constantly modified and improved to provide safe and consistent operations of the rig. During a Run, the control system monitors the various safety and operational aspects of system and executes pre-determined actions in response to measured and detected events. Events include things such as over-pressures, over- and under-temperatures, loss of fuel flow, low or high tank fuel levels, taking too long to fill tanks, are just a few of the conditions that can trigger the control system to take some sort of action. Depending on the type of anomaly detected by the control system, one of several general actions can be taken.

FSS Behavior During an Emergency or Unscheduled Shutdown

The FSS is programmed to operate 24/7 with minimal Operator intervention. It operates unattended for about 16 hours each week day and 24 hours each day on weekends. During test programs, anomalies can occur that can trigger the control system to take action. In all cases, detected anomalies always result in a shutdown of some sort. Four potential overall shutdown classes have been developed to react to various anomalies and conditions. Four different shutdown sequences were developed to respond to each of the anomaly classes. Each sequence is specifically designed to protect test integrity, personnel safety and the FSS hardware by reducing, as quickly as possible, the overall temperatures and pressures in the system while safely maintaining selected critical fuel flows. The four shutdown modes are **Normal Shutdown**, **End-of-Cycle Shutdown**, **Mid-Cycle Shutdown**, and **Emergency Shutdown**. Each shutdown mode is triggered by specific events. While these shutdowns are triggered by the control system based on existing conditions, the Operator can manually initiate any one of these shutdown modes.

Normal Shutdown

A **Normal Shutdown** is a routine shutdown mode and is not in response to any detected anomaly but a part of the Run sequence plan. It is executed at the end of a programmed sequence of mission cycles. This involves a controlled shutdown involving turning off heaters, maintaining fuel flows until temperatures in critical areas of the rig (those areas most likely to affect thermal stability determinations) are below established limits and then a final power-off.

End-of-Cycle Shutdown

An **End-of-Cycle Shutdown** is executed when the rig detects an anomaly that is not immediately detrimental to rig or test integrity but still needs Operator intervention prior to continuing the overall program. In the End-Of-Cycle Shutdown, the rig is allowed to complete the current active mission normally and then at the end of that mission, a Normal Shutdown is executed. If at any time during the balance of the continued mission the rig detects further anomalies that would be more critical than those that triggered the End-Of-Cycle Shutdown initially, a Mid-Cycle Shutdown is immediately executed.

Mid-Cycle Shutdown

A **Mid-cycle Shutdown** is executed when the rig detects an anomaly that could potentially impact the overall integrity of the rig and data if not immediately dealt with. In the Mid-Cycle Shutdown, no matter what part of the mission cycle is being executed, the mission is terminated in a controlled fashion by immediately executing a Normal Shutdown.

Emergency Shutdown

An **Emergency Shutdown** is executed only rarely and is triggered by the detection of no or very low flow anywhere on the rig. An Emergency Shutdown can be executed at any time – either during a mission or during one of the other shutdown sequences. In an Emergency Shutdown, the rig is immediately powered down no matter what the mission cycle or mission condition. Unlike the other shutdown modes, a NORMAL SHUTDOWN IS NOT EXECUTED. This shutdown is akin to 'pulling the plug' and is only executed when there is a risk that low or no fuel flow can irrevocably damage major rig hardware.

Uncontrolled Shutdowns

There is always the possibility of a shutdown due to a utility-based power failure. In this case, the rig will shut down immediately. There is not provision for backup power to the main rig in the test bay. Without power, no control is possible during this type of shutdown, However, the hardware on the FSS is designed so that in the event of a power outage, all rig components 'fail safe' from an operator and rig perspective. Since no control is possible during this type of shutdown, it is likely that the test integrity will be compromised. To aid in this determination, battery backup is provided on critical computer and I/O systems. This allows limited data to be collected during the shutdown. This data can later be assessed to determine if the test integrity was indeed compromised.

General Operation of the FSS

Generally, the FSS operates by bringing fuel on-board the system into Wing and Body tanks. Fuel is then pumped through engine fuel system components at specified flow rates, pressures and temperatures. Downstream of the Fuel-Cooled Oil Cooler a portion of the fuel is recirculated back to the body tank to simulate fuel recirculation on-board the aircraft for thermal management. Remaining fuel flows through the balance of the system and is discarded to the fuel farm scrap tank.

There are two major operational modes that are used for testing. In mission cycle testing, also known as Generic Durability Test Cycle (GDTC) mode, the FSS 'flies' 65 missions (or more) in sequence. Each mission consists of mission elements such as Ground Idle, High Power Cruise, Low Power Cruise, Combat, and Descent. These elements are sequenced to logically replicate an actual aircraft mission.

The second testing mode is the Extended Duration Thermal Stability Test (EDTST) mode. In this mode, the FSS is operated steady state at one set of conditions (typically a Ground Idle-type condition) for 72 hours or more. As with GDTC testing, there is a recirculation loop in addition to the normal flow loop. The only difference in operation between GDTC and EDTST is that is one mission element condition at steady state.

Prior to FSS operation (either GDTC or EDTST modes), fuel is prepared for the test and located in one of three tanks on the S-Farm which the FSS has direct and automated access to. The FSS rig itself is prepared by cleaning and/or replacing key test elements such as the Servo Valve (SV), the Flow Divider Valve (FDV), the Burner Feed Arm (BFA), the Nozzle Screen Simulator (NSS) and the various screens and filters. Heat exchanges like the Airframe Heat Exchanger (AFHX) and the HP Pump Heat Exchanger (HPHX) and the Fuel-Cooled Oil Cooler (FCOC) are not cleaned or replaced from test to test unless necessary.

For valves such as the SV and FDV, pre-test valve hysteresis measurements are made to describe the valve performance. Post-test, valve hysteresis measurements are again made to determine any impact of deposition in these valves. These valve components are also photographed for comparison to clean components and previous tests.

The BFA is replaced for each test. Post-test, the BFA is cut up into 1-inch sections and subjected to carbon burn-off analysis in a Leco Carbon Analyzer where internal carbon deposition is measured. These measurements. In addition to BFA carbon deposition measurements, the hot spot temperature of the BFA (which is actively heated by an RF heater to simulate the temperature of compressor discharge air that the fuel nozzle stem is subjected to in the actual engine) is monitored. Any rise in temperature at this hot spot has been shown to correlate with increased deposition in the BFA.

Selected screens are weighed pre- and post-test for deposit mass accumulation. These devices are also photographed and subjected to Scanning Electron Microscope (SEM) evaluation to study the deposit morphology on these screens.

It is important to note that in both GDTC and EDTST mode operations, the FSS runs 24/7. It is equipped with all appropriate alarms, shut-down sequences and safety features to allow safe operations while being unattended.

GDTC (Mission Cycle) Mode Operation

In mission mode testing, as described earlier, the FSS operates in mission cycles with each mission consisting of one or more mission segments. Each segment is defined by a set of flow, temperature and pressure conditions which emulate that segment in a real-world aircraft mission. Table C-1 shows the typical mission segments and mission conditions for mission-mode testing. Each mission is approximately 112 minutes in duration. Typically an FSS run will consist of 65 missions which will span 6-7 calendar days of continual 24/7 operations.

The first two mission cycles in a GDTC-mode run are used to establish condition set points for FSS operation. As each mission segment is run, FCOC and BFA heater settings are manually established to achieve the desired conditions for those devices. In the case of the FCOC, the RF heat applied to the FCOC is manually set to achieve the desired bulk fuel outlet temperature from the FCOC. For the BFA, the RF heater is set to achieve the desired wetted-wall temperature at the hot spot along the BFA tube. These heater settings are recorded for each individual mission segment. Fuel flow (both primary core flow and recirculation flow) are controlled automatically by the FSS to achieve the specified flow rates at each mission segment. For the AFHX and the HPHX, these heaters are also automatically controlled to the desire set point bulk fuel outlet temperature. Only the FCOC and BFA heaters are manually controlled. In the second mission cycle, the manual FCOC and BFA heater settings are checked and adjusted to achieve the desire conditions. These manual final manual settings are then entered into the control system and all further mission cycles use these manual heater settings. They are not adjusted during the run. The run the proceeds to the set number of desired missions.

Table C - 1 Generic Durability Test Cycle Standard Conditions

Generic Durability Test Cycle (GDTC) Standard Operating Conditions								
Mission Parameter	Mission Control Point	Mission Segment Number and Name					
		Ground Idle 1	Hi Pwr Cruise	Lw Pwr Cruise	Combat	Descent	Ground Idle 2
		1	2	3	4	5	6
Start Time, El. Min	N/A	0	25	46	88	91	97
End Time, El. Min	N/A	25	46	88	91	97	112
Duration, Min	N/A	25	21	42	3	6	15
Burn Flow, PPH	4	16.7	52	35	169.1	23.2	16.7
Recirc Flow, PPH	3	27.5	14	23	0	44.2	27.5
FCOC Fuel In, °F	2	300	300	300	NC	300	300
FCOC Fuel Out, °F	3	325	325	325	NC	325	325
AFHX Fuel Out, °F	1	285	285	285	NC	285	285
BFA Max WWT, °F	4	450	450	450	NC	450	450
NC = Not Controlled NA = Not Applicable							

Table C - 2 Generic Durability Test Cycle Low-Temperature Conditions

Generic Durability Test Cycle (GDTC) Low Tempeature (LT) Operating Conditions							
Mission Parameter	Mission Control Point	Mission Segment Number and Name					
		Ground Idle 1	Hi Pwr Cruise	Lw Pwr Cruise	Combat	Descent	Ground Idle 2
		1	2	3	4	5	6
Start Time, El. Min	N/A	0	25	46	88	91	97
End Time, El. Min	N/A	25	46	88	91	97	112
Duration, Min	N/A	25	21	42	3	6	15
Burn Flow, PPH	4	16.7	52	35	169.1	23.2	16.7
Recirc Flow, PPH	3	27.5	14	23	0	44.2	27.5
FCOC Fuel In, °F	2	300	300	300	NC	300	300
FCOC Fuel Out, °F	3	325	325	325	NC	325	325
AFHX Fuel Out, °F	1	285	285	285	NC	285	285
BFA Max WWT, °F	4	500	500	500	NC	500	500
NC = Not Controlled NA = Not Applicable							

Table C - 3 Generic Durability Test Cycle Moderate-Temperature Conditions

Generic Durability Test Cycle (GDTC) Moderate Tempeature (MT) Operating Conditions							
Mission Parameter	Mission Control Point	Mission Segment Number and Name					
		Ground Idle 1	Hi Pwr Cruise	Lw Pwr Cruise	Combat	Descent	Ground Idle 2
		1	2	3	4	5	6
Start Time, El. Min	N/A	0	25	46	88	91	97
End Time, El. Min	N/A	25	46	88	91	97	112
Duration, Min	N/A	25	21	42	3	6	15
Burn Flow, PPH	4	16.7	52	35	169.1	23.2	16.7
Recirc Flow, PPH	3	27.5	14	23	0	44.2	27.5
FCOC Fuel In, °F	2	325	325	325	NC	325	325
FCOC Fuel Out, °F	3	350	350	350	NC	350	350
AFHX Fuel Out, °F	1	285	285	285	NC	285	285
BFA Max WWT, °F	4	500	500	500	NC	500	500
NC = Not Controlled NA = Not Applicable							

Table C - 4 Generic Durability Test Cycle High-Temperature Conditions

Generic Durability Test Cycle (GDTC) High Temperature (HT) Operating Conditions								
Mission Parameter	Mission Control Point	Mission Segment Number and Name					
		Ground Idle 1	Hi Pwr Cruise	Lw Pwr Cruise	Combat	Descent	Ground Idle 2
		1	2	3	4	5	6
Start Time, El. Min	N/A	0	25	46	88	91	97
End Time, El. Min	N/A	25	46	88	91	97	112
Duration, Min	N/A	25	21	42	3	6	15
Burn Flow, PPH	4	16.7	52	35	169.1	23.2	16.7
Recirc Flow, PPH	3	27.5	14	23	0	44.2	27.5
FCOC Fuel In, °F	2	325	325	325	325	325	325
FCOC Fuel Out, °F	3	375	375	375	375	375	375
AFHX Fuel Out, °F	1	285	285	285	285	285	285
BFA Max WWT, °F	4	500	500	500	500	500	500

NC = Not Controlled NA = Not Applicable

Figure C - 25 shows a plot of GDTC flows and the mission segment in which they occur.

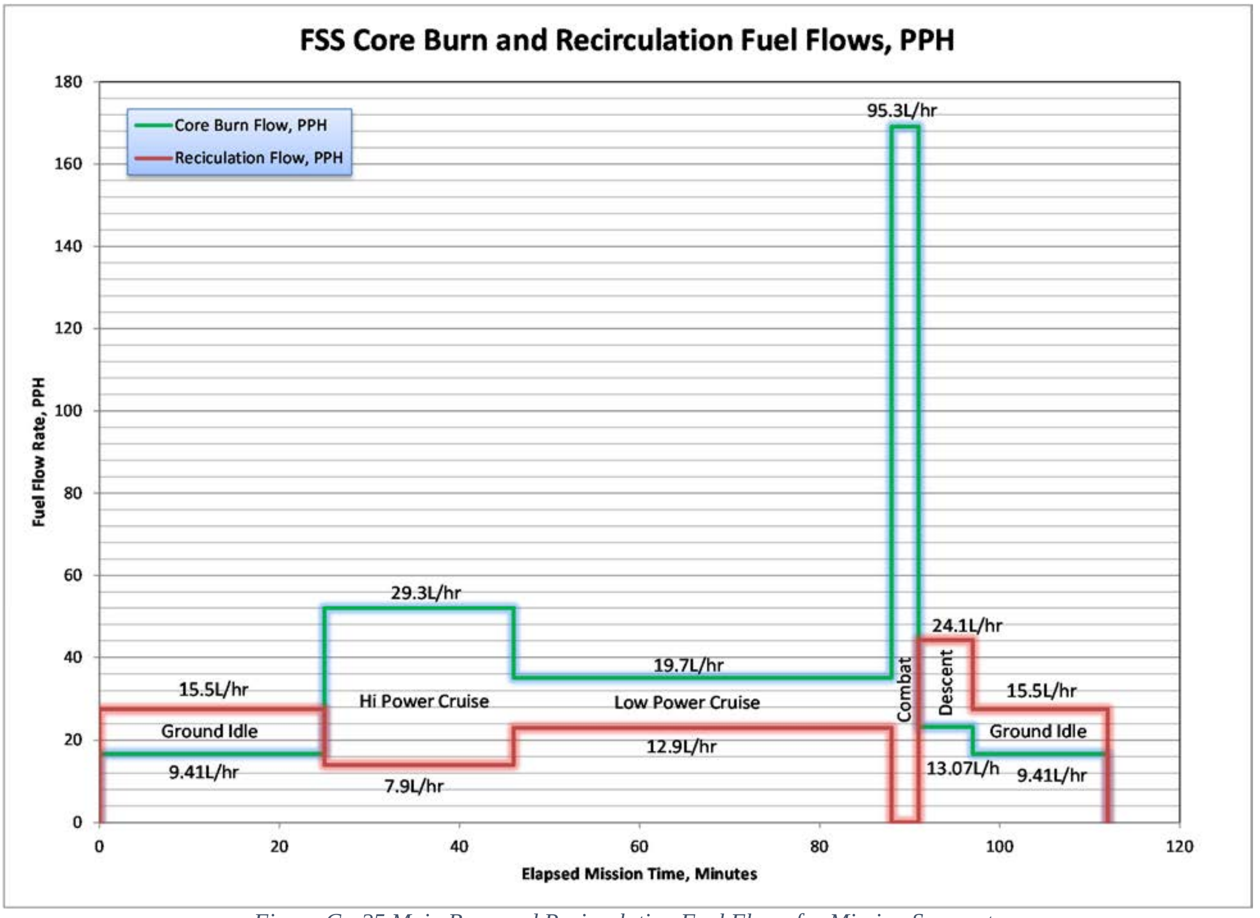

Figure C - 25 Main Burn and Recirculation Fuel Flows for Mission Segments

EDTST (Steady State) Mode Operation:

In EDTST mode, the FSS is operated as in GDTC mode except that mission segments are not executed in a cycle. Run conditions are established according to the run set point profile desired. As in GDTC testing, the FCOC and BFA heater settings are manually determined in order to achieve desire operating conditions. These heater settings are adjusted manually during the first 2 hours of the run. After 2 hours,

these heater settings are 'locked in' and do not change for the duration of the EDTST run, which is typically 72 hours.

Three EDTST-mode condition sets have been developed for the FSS. These are generically described as Low Temperature (LT), Moderate Temperature (MT) and High Temperature (HT). In these three sets of conditions the only thing that changes is the temperature profile in the system. Fuel flows and pressures remain the same and are typically consistent with mission-cycle Ground Idle mission segment conditions. Table C - 5 shows the specific parameters of these conditions.

Table C - 5 FSS EDTST-Mode Operating Conditions For LT, MT and HT Profiles

EDTST MODE RUN CONDITIONS			
Run Parameter	LT Conditions	MT Conditions	HT Conditions
Main Burn Flow, PPH	16.7	16.7	16.7
Recirculation Flow, PPH	27.5	27.5	27.5
Airframe HX Bulk Fuel Out	285 °F (140 °C)	285 °F (140 °C)	285 °F (140 °C)
FCOC Bulk Fuel Inlet Temperature	300 °F (149 °C)	325 °F (163 °C)	325 °F (163 °C)
FCOC Bulk Fuel Outlet Temperature/BFA Bulk Fuel Inlet Temperature	325 °F (163 °C)	350 °F (177 °C)	375 °F (190 °C)
BFA Max Wetted Wall	510 °F (265 °C)	510 °F (265 °C)	510 °F (265 °C)

APPENDIX D
Table D - 1 Summary Data All Testing

Assessing Fuel Thermal Margin In Current Aviation Turbine Fuels																																		
Run No.	Test Description	Fuel CODE	Start Date	Test Type	Test MODE	Missions or Hrs	Fuel Type	FUEL NOTE	Additive	FDV Hysteresis						SERVO Hysteresis						FCOC	BFA						TMS		F303	F304	F702	Notes
										Spread, %	Shift PPH	Skew PSID	Flow Range Shift, PPH	Flow Midpoint Shift, PPH	Rating	Spread, %	Shift PPH	Skew PSID	Flow Range Shift, PPH	Flow Midpoint Shift, PPH	Rating	Wit Tube Tot Eff Carbon, µg	Tot Eff Carbon µgrams	Max Effective C @ Hot Spot, µg	ΔMWWT °F	Avg WWT Test Start °F	Avg WWT Test End °F	ΔAvg WWT °F	Effective Carbon µg	Delta P	Effective Carbon µg	Effective Carbon µg	Effective Carbon µg	
149	Jet A, LT Conditions	POSF-12831	18-Jul-16	ED	1 LT	72 hrs	Jet A	Gulf Coast		-3.8	-2	0.8	-3.1	-1.6	Minor	1.5	0.1	0.3	-0.3	-0.1	None	523	3053	488	-0.2	492.95	486.63	-6.32	8.4		77	25	42	
150	Jet A, MT Conditions	POSF-12831	1-Aug-16	ED	2 MT	72 hrs	Jet A	Gulf Coast		-0.5	-1.4	0.2	-1.3	-0.6	None	1	-1.5	-0.5	-0.1	-0.1	Minor	185	2954	456	-0.37	493.83	466.46	-27.37	13		69.7	48.1	571.8	
151	Jet A, HT Conditions	POSF-12831	8-Aug-15	ED	3 HT	72 hrs	Jet A	Gulf Coast		12.8	-2	1.3	-3.1	-1.6	Severe	21	-0.5	-0.4	0.4	0.2	Moderate	260.6	5077	709.5	-4.8	494.84	489.56	-5.28	30.6		107.1	77.9	1617.4	
152	Jet A, Design-point Conditions	POSF-12831	17-Aug-16	GD	GDTC	65 MSNs	Jet A	Gulf Coast																				0						
153	F-24, LT Conditions	POSF-12843	29-Aug-16	ED	1 LT	72 hrs	F24	Ft. McCoy		15.8	-0.6	-0.2	-2.9	-1.5	Severe	-5	-0.3	-0.5	0.2	0.1	Minimal	250.1	9366	1812	12.15	487.28	493.43	6.15	26.6		98	62.7	135.4	
154	F-24, MT Conditions	POSF-12843	6-Sep-16	ED	2 MT	72 hrs	F24	Ft. McCoy		45.4	-5.7	2.5	-6.6	-3.3	Non Funct	53.9	-3.6	-0.4	-0.7	-0.4	Non Funct	410.7	81705	12432	105.39	492.25	556.69	64.44	89.7		124.8	222.3	151.4	
155	F-24, MT Conditions	POSF-12843	19-Sep-16	ED	2 MT	72 hrs	F24+100	Ft. McCoy	100	13.5	0.9	-0.2	0.6	0.3	Minor	3.3	-1.4	-0.5	0.2	0.1	Minor	327.8	433.2	69.3	-0.63	489.84	495.4	5.56	8.7		13.2	26.8	268.4	
156	Jet A, MT Conditions (Invalid)	POSF-12831		ED	2 MT	<72 hrs	Jet A	Gulf Coast																				0						Invalid Run - multiple shutdowns
157	Jet A, HT conditions	POSF-12831		ED	3 HT	72 hrs	Jet A	Gulf Coast		28.1	-5.6	3.1	-8.2	-4.1	Non Funct	13.7	-3.1	-0.5	-0.6	-0.3	Severe	176.4	3708	906.6	-13.3	496.23	485.34	-10.89	239.9		146.2	2986		
158	F-24, MT Conditions	POSF-12843		ED	2 MT	72 hrs	F24	Ft. McCoy		0.2	-1.2	0.7	-4.6	-2.3	Minor+	267.7	-15.7	0	-0.5	-0.3	Non Funct	286	40973	8121	41.42	484.62	519.64	35.02	52.9		128.8	176.7	363.4	
159	F-24+100, HT Conditions	POSF-12843		ED	3 HT	72 hrs	F24 +100	Ft. McCoy	100	4.4	-0.2	0.3	2.7	1.4	Minor	1.6	-1.7	-0.6	-0.3	-0.2	Minor	455.1	2453	416.3	3.44	493.59	496.59	3	18.1		23.1	40.8	109.2	
160	Jet A, HT Conditions	POSF-12831		ED	3 HT	24 hrs	Jet A	Gulf Coast																				0						Invalid Run 24 hrs
161	Jet A, HT Conditions	POSF-12831		ED	3 HT	63 hrs	Jet A	Gulf Coast		11.5	-1.9	0.9	0.6	0.3	Severe	9.6	0.5	-0.1	0	0	Moderate	652.6	6278	934.5		490.33	491.77	1.44	33.7		165.8	174.9	2022.7	63-hour run
162	F-24+MDA, MT Conditions	POSF-12843		ED	2 MT	72 hrs	F24 +MDA	Ft. McCoy	MDA	35.2	1.05	0.5	-1.3	-0.7	Moderate-	5.9	-1.4	-0.7	-0.9	-0.4	Moderate-	188.9	7851	2039	28.25	484.68	499.56	14.88	24.7		82.4	62.8	68.3	
163	Jet A, HT Conditions	POSF-12831		ED	3 HT	72 hrs	Jet A	Gulf Coast		35.7	-5.4	3.8	3.7	1.9	Non funct	34.8	-3.7	-0.1	-0.5	-0.3	Non funct	537	12733	1792	-21.85	488.63	475.95	-12.68	246.2		281.9	169	2598.7	
164	Jet A, HT Conditions	POSF-12831		ED	3 HT	72 hrs	Jet A	Gulf Coast		6.4	-1.6	0.9	-3	-1.5	Moderate	25.6	-0.8	-0.2	-0.3	-0.1	Moderate	414	6748	1030.8	-10.75	491.88	486.6	-5.28	38		171.2	130.4	1854	

Note that Runs 156 and 160 are invalid Runs. Run 156 suffered multiple unscheduled shutdowns, one of which was a loss of power to the testing facility. Run 160 exhibited extreme deposition in the first 24 hours of the run and was presumed to be due to contamination from the previous run. The Run was terminated, system rinsed and Run 161 was started. Run 161 exhibited 'normal' behavior for that fuel.

Organization of Data Packages in Appendices:

Run Condition	Gulf Coast Fuel Run Number	Ft. McCoy Fuel Run Number
LT	149	153
MT	150	154, 158
HT	151, 157, 161, 163, 164	N/A
MT w/+100	N/A	155
HT w/+100	N/A	159
MT w/MDA	N/A	162
MSN Mode	152	N/A

APPENDIX E
TMS Comparison Data - All Testing

TMS Comparisons						
Run	**Mode**	**Fuel**	**Additive**	**TMS Effective Carbon, Total µg**	**Delta Mass µg**	**TMS IMAGE**
149	LT	12831	N/A	8.4	0	
150	MT	12831	N/A	13	0	
151	HT	12831	N/A	30.6	100	
152	MSN	12831	N/A	15.9	0	
153	LT	12843	N/A	26.8	400	
154	MT	12843	N/A	89.7	410	

Figure E - 1 TMS Comparisons, Runs 149-154

TMS Comparisons						
Run	**Mode**	**Fuel**	**Additive**	**TMS Effective Carbon, Total µg**	**Delta Mass µg**	**TMS IMAGE**
155	MT	12843	GE +100	8.7	0	
156	MT		N/A	Run Terminated 63 Hours - Mech Failure		
157	HT	12831	N/A	239	520	
158	MT	12843	N/A	52.9	22	
159	HT	12843	GE +100	18.1	0	
160	HT	12831	N/A	Run Terminated 24 Hours - High BFA MWWT		
161	HT	12831	N/A	33.7	0	
162	MT	12843	MDA	24.7	0	

Figure E - 2 TMS Comparisons, Runs 155-162

TMS Comparisons						
Run	**Mode**	**Fuel**	**Additive**	**TMS Effective Carbon, Total μg**	**Delta Mass μg**	**TMS IMAGE**
163	HT	12831	N/A	246.2	920	
164	HT	12831	N/A	38	130	

Figure E - 3 TMS Comparisons, Runs 163 and 164

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APPENDIX F - RUN 149 DATA PACKAGE

Run Conditions: EDTST Mode, LT Conditions
Fuel ID: POSF-12831, Gulf Coast Jet A
Airframe Heat Exchanger Bulk Fuel Output: 285 °F
Fuel-Cooled Oil Cooler Bulk Fuel Output: 325 °F
Burner Feed Arm Max Wetted Wall Temperature: 510 °F
Run Duration: 72 Hours

DATA SUMMARY

Run 149; Run Type: EDTST; Op Mode: LT; MSNs: N/A; EDTST Run Hours: 72 Fuel ID#: POSF-12831; Run Tank: S-15; Run Type: EDTST; Op Mode: LT Fuel Type: Jet A; Additive(s): None AFHX Out: 285 °F; FCOC In: 300 °F; FCOC Out: 325 °F; BFA MWWT: 510 °F;

Component/Device	Serial No.	Pre-Test %	Post-Test %	Spread (Pre/Post Delta), %	Shift, PPH	Skew, PSID	Flow Range Shift, PPH	Flow Midpoint Shift, PPH	Overall Rating	Hysteresis Area Change (PPH-DP)
FDV	1171	0.5	-3.3	-3.8	-2.0	0.8	39.4	19.7	Minimal	4
Servo2	027	1.2	2.6	1.5	0.1	0.3	114.6	57.3	None	77

Effective Carbon - µgrams

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	53.9	69.7	41.7	33.8	54.1					
BFA	44.1	100.4	164.6	318.1	359.3	416.3	488.5	452.8	418.5	290.9
Total FCOC Carbon, µgrams		253.3	µgrams	0.3	mgrams					
Total BFA Carbon, µgrams		3053.6	µgrams	3.1	mgrams					

SCREENS	Total Carbon, µg	Background Carbon, µg	Effective Carbon, µg	MWWT Start	MWWT End	Delta BFA MWWT	TE	BFA AWWT Start	BFA AWWT End	Delta BFA AWWT
TMS	8.7	0.3	8.4	511.39	511.77	0.38	MAX	492.95	493.10	0.16
F303	102.6	25.4	77.2	505.98	505.03	-0.94	TE325	**SV Inlet**	**FDV Inlet**	**BFA Inlet**
F304	38.1	12.9	25.2	509.41	508.63	-0.78	TE324	**(TE702)**	**(TE313)**	**(TE316)**
F305	0.0	0.0	0.0	511.39	511.77	0.38	TE323	319	306	303
F702	55.4	12.9	42.5	502.48	502.50	0.02	TE322			

Effective Carbon Deposition - µgrams/cm^2

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	14.8	19.1	11.4	9.3	14.8					
BFA	25.6	58.3	95.5	184.6	208.5	241.7	283.6	262.8	242.9	168.9

TMS Mass Change - grams

Component/Device	Tare, g	Mass, g	Mass Gain, g
TMS	0.08687	0.08687	0.00000
F303	7.11244	7.11140	-0.00104
F304	3.04891	3.04619	-0.00272
F305	3.06329	3.06316	-0.00013
F702	0.00000	0.00000	0.00000

Hysteresis Ratings:

- NONE: indicating that the pre-test and post-test hysteresis curves, for all intents and purposes, are nearly indistinguishable from one another. Minor differences may be seen between the pre-test and post-test curves but these are very small.
- Minor: There are small differences between per- and post-test curves. The spread for these curves is typically within 5% of one another. There may be some small changes in shift and skew for the valve. This degree of hysteresis would not be expected to alter the functional nature of the valve.
- Moderate: There are definite differences between pre-and post-test curves. There may be definite differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically between 5% and 15%. This degree of hysteresis might be expected to alter the functional nature of the valve.
- Severe: There are pronounce differences between pre-and post-test curves. There may be pronounced differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically in excess 15%. This degree of hysteresis would be considered out-of-spec for the valve.
- Non-Functional: There are major differences between pre-and post-test curves. There may be major differences in shift and skew as well. The hysteresis curve will exhibit flat segments (either vertically or horizontally). Shift and skew have majorly changed the performance envelope of the valve. This degree of hysteresis would cause the valve to be non-functional or unresponsive over small or large portions of the performance range of the valve.

Figure F- 1 Run 149 Data Summary

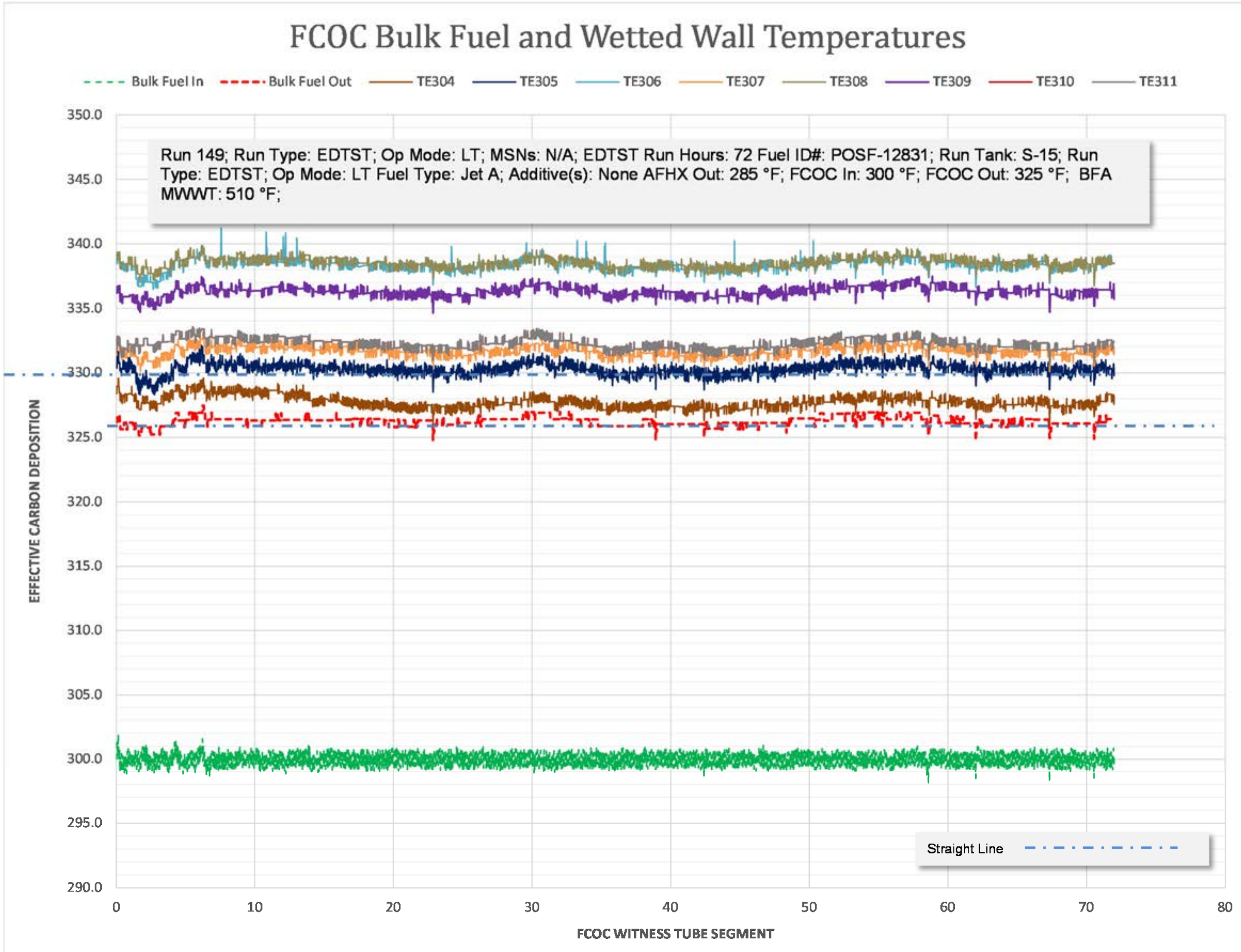


Figure F- 2 FCOC Bulk Fuel and Wetted Wall Temperatures

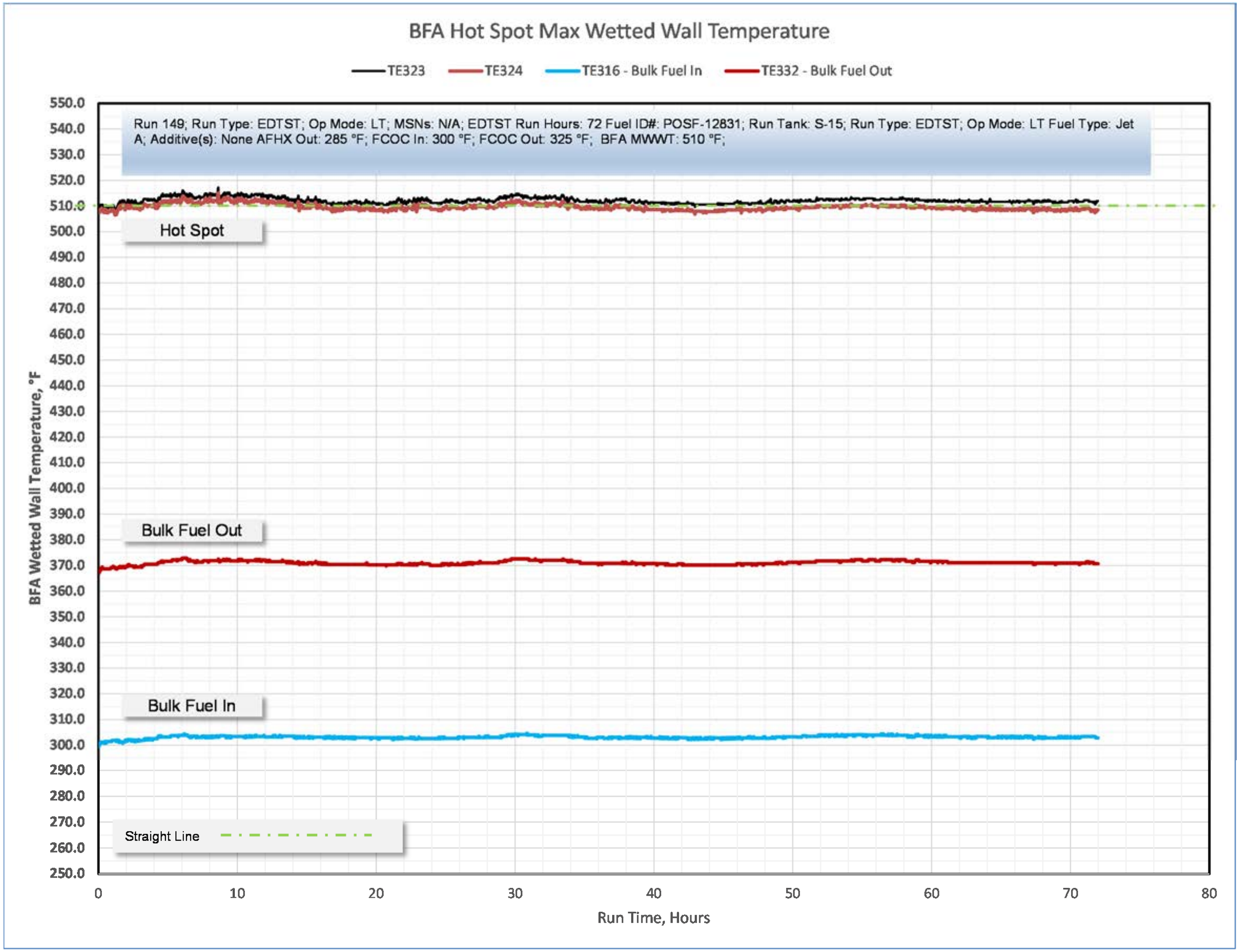


Figure F- 3 BFA Hot Spot Max Wetted Wall And Bulk Fuel Temperatures

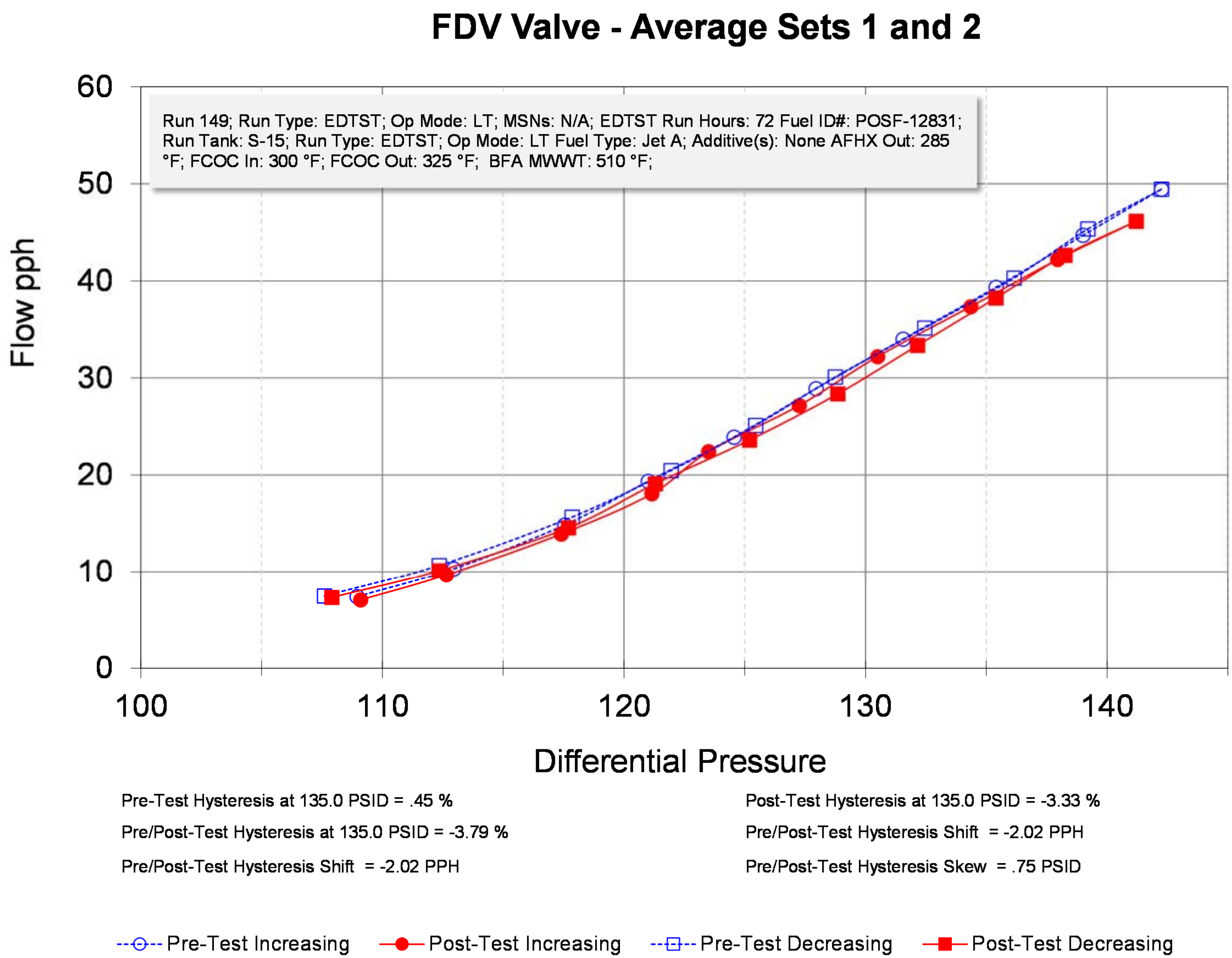


Figure F- 4 FDV Hysteresis

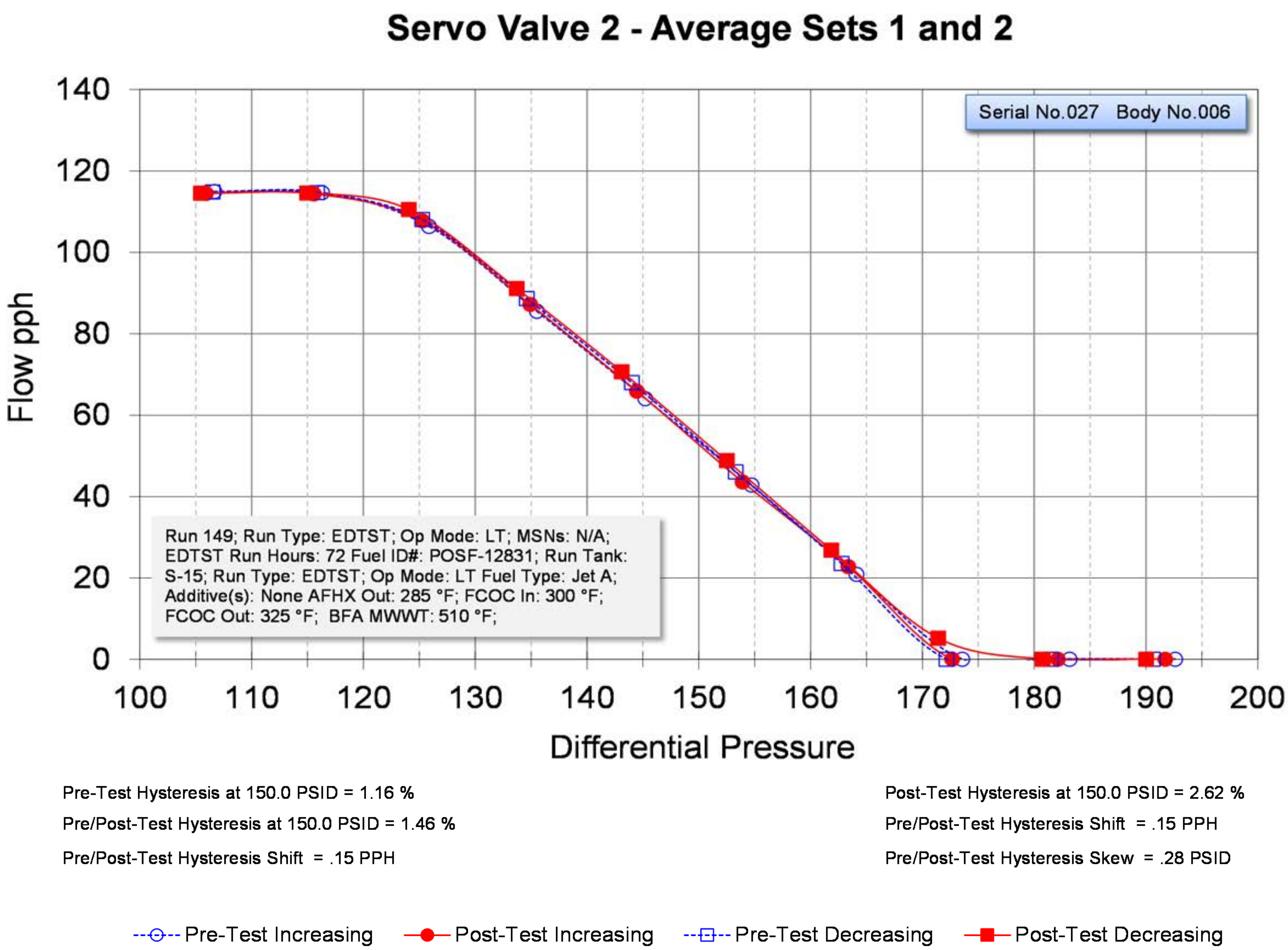


Figure F- 5 Servo Valve Hysteresis

Figure F- 6 FDV Components - Comparison to Clean

Servo Valve and Nozzle Screen Simulator Components – Comparison To Clean - Run 149

Clean

Run 149 POSF12831 LT

Figure F- 7 Servo Valve and Nozzle Screen Components - Comparison to Clean

TMS Screens Comparison to Clean - Run 149

Figure F- 8 TMS Screen Top and Bottom - Comparison to Clean

GCxGC Results

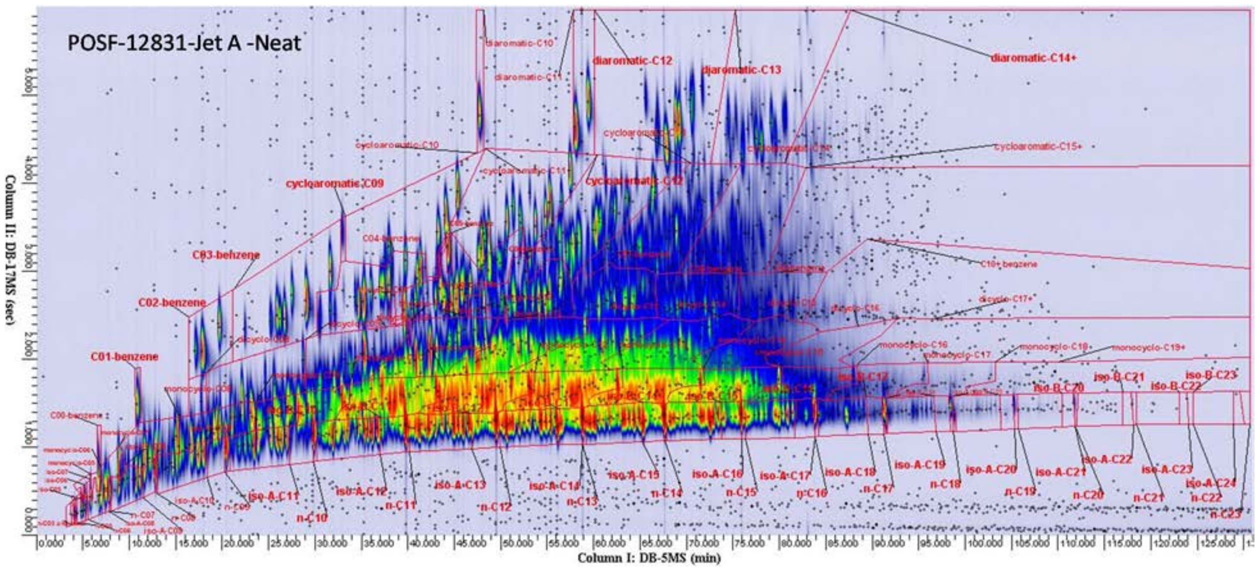


Figure F- 9 GCxGC Summary POSF-12831 Jet A Neat

Table F- 1 GCxGC Tabulated Data POSF-12831 Jet A Neat

GCxGC Summary		
Hydrogen content (weight %)	**13.9**	
Average Molecular Wt (g/mole)	**168**	
POSF-12831-Jet A Neat		
	Weight %	**Volume %**
Aromatics		
Alkylbenzenes		
benzene (C06)	<0.01	<0.01
toluene (C07)	0.10	0.10
C2-benzene (C08)	0.42	0.39
C3-benzene (C09)	0.88	0.82
C4-benzene (C10)	1.47	1.37
C5-benzene (C11)	1.78	1.66
C6-benzene (C12)	1.69	1.58
C7-benzene (C13)	1.21	1.13
C8-benzene (C14)	0.99	0.92
C9-benzene (C15)	0.55	0.51
C10+-benzene (C16+)	0.24	0.23
Total Alkylbenzenes	**9.33**	8.69
Diaromatics (Naphthalenes, Biphenyls, etc.)		
diaromatic-C10	0.11	0.08
diaromatic-C11	0.51	0.40
diaromatic-C12	0.96	0.77
diaromatic-C13	0.58	0.47
diaromatic-C14+	0.18	0.15
Total Alkylnaphthalenes	**2.33**	1.87
Cycloaromatics (Indans, Tetralins,etc.)		
cycloaromatic-C09	0.03	0.02
cycloaromatic-C10	0.53	0.44
cycloaromatic-C11	1.54	1.32
cycloaromatic-C12	1.67	1.45
cycloaromatic-C13	1.54	1.35
cycloaromatic-C14	0.94	0.83
cycloaromatics-C15+	0.30	0.26
Total Cycloaromatics	**6.56**	5.67
Total Aromatics	**18.22**	**16.24**
Paraffins		
iso-Paraffins		
C07 & lower -isoparaffins	0.24	0.29
C08-isoparaffins	0.43	0.49
C09-isoparaffins	0.58	0.65
C10-isoparaffins	1.46	1.61
C11-isoparaffins	2.76	2.99
C12-isoparaffins	4.56	4.94
C13-isoparaffins	4.75	5.04
C14-isoparaffins	4.49	4.72
C15-isoparaffins	3.64	3.81
C16-isoparaffins	1.50	1.55
C17-isoparaffins	0.46	0.47
C18-isoparaffins	0.15	0.16
C19-isoparaffins	0.08	0.08
C20-isoparaffins	0.05	0.05
C21-isoparaffins	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01
Total iso-Paraffins	**25.16**	26.85

n-Paraffins		
n-C07 & lower	0.19	0.22
n-C08	0.38	0.43
n-C09	0.56	0.62
n-C10	1.00	1.10
n-C11	2.89	3.13
n-C12	3.11	3.32
n-C13	2.77	2.94
n-C14	2.38	2.50
n-C15	1.40	1.46
n-C16	0.34	0.36
n-C17	0.12	0.13
n-C18	0.04	0.04
n-C19	0.02	0.02
n-C20	<0.01	<0.01
n-C21	<0.01	<0.01
n-C22	<0.01	<0.01
n-C23	<0.01	<0.01
Total n-Paraffins	**15.22**	16.30
Cycloparaffins		
Monocycloparaffins		
C07 & lower monocycloparaffins	0.49	0.51
C08-monocyclocycloparaffins	0.71	0.72
C09-monocyclocycloparaffins	1.49	1.51
C10-monocyclocycloparaffins	2.36	2.32
C11-monocyclocycloparaffins	5.59	5.63
C12-monocyclocycloparaffins	5.49	5.49
C13-monocyclocycloparaffins	5.81	5.75
C14-monocyclocycloparaffins	4.05	4.02
C15-monocyclocycloparaffins	2.58	2.55
C16-monocyclocycloparaffins	0.93	0.92
C17-monocyclocycloparaffins	0.23	0.22
C18-monocyclocycloparaffins	0.06	0.06
C19+-monocyclocycloparaffins	0.04	0.03
Total Monocycloparaffins	**29.82**	29.73
Dicycloparaffins		
C08-dicycloparaffins	0.02	0.02
C09-dicycloparaffins	0.27	0.25
C10-dicycloparaffins	0.71	0.64
C11-dicycloparaffins	2.43	2.28
C12-dicycloparaffins	2.60	2.46
C13-dicycloparaffins	2.89	2.73
C14-dicycloparaffins	1.89	1.78
C15-dicycloparaffins	0.63	0.59
C16-dicycloparaffins	0.04	0.03
C17+-dicycloparaffins	0.03	0.03
Total Dicycloparaffins	**11.50**	10.81
Tricycloparaffins		
C10-tricycloparaffins	<0.01	<0.01
C11-tricycloparaffins	0.07	0.06
C12-tricycloparaffins	<0.01	<0.01
Total Tricycloparaffins	**0.08**	0.06
Total Cycloparaffins	**41.40**	40.61
Average Molecular Formula - C	12.1	
Average Molecular Formula - H	23.2	

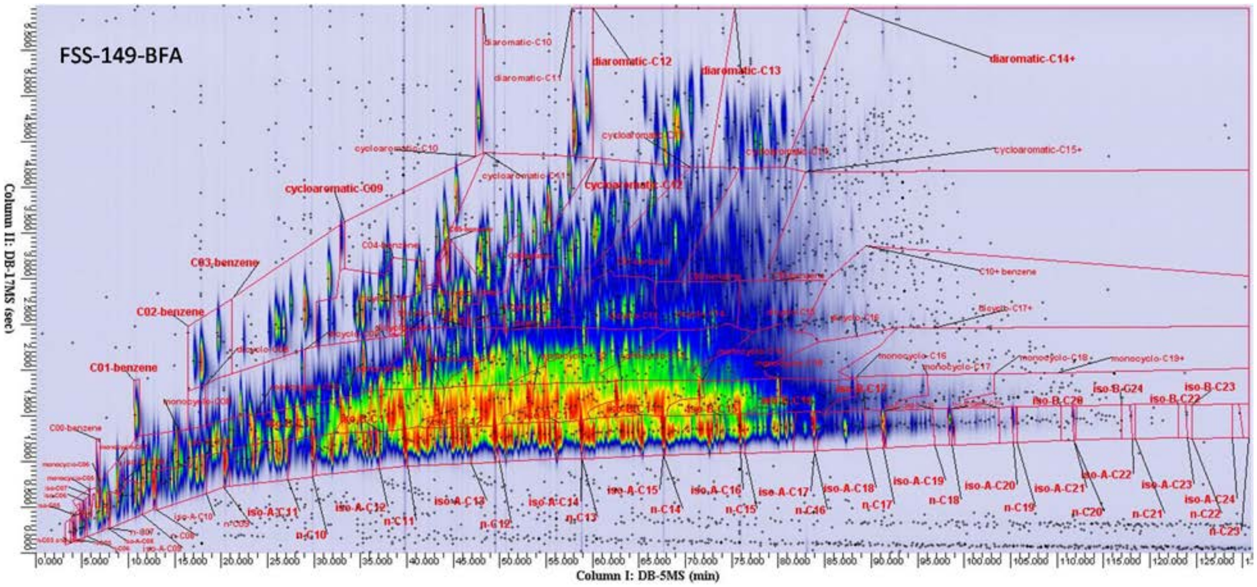


Figure F- 10 GCxGC Summary Fuel From BFA Outlet End Of Run

Table F- 2 GCxGC Tabulated Data - Fuel From BFA Outlet End Of Run

GCxGC Summary		
Hydrogen content (weight %)	13.9	
Average Molecular Wt (g/mole)	168	
	FSS149-BFA	
	Weight %	Volume %
Aromatics		
Alkylbenzenes		
benzene (C06)	<0.01	<0.01
toluene (C07)	0.10	0.10
C2-benzene (C08)	0.42	0.39
C3-benzene (C09)	0.87	0.81
C4-benzene (C10)	1.47	1.37
C5-benzene (C11)	1.78	1.65
C6-benzene (C12)	1.70	1.58
C7-benzene (C13)	1.20	1.12
C8-benzene (C14)	1.00	0.94
C9-benzene (C15)	0.58	0.54
C10+-benzene (C16+)	0.24	0.23
Total Alkylbenzenes	**9.35**	8.71
Diaromatics (Naphthalenes, Biphenyls, etc.)		
diaromatic-C10	0.11	0.08
diaromatic-C11	0.51	0.40
diaromatic-C12	0.96	0.77
diaromatic-C13	0.58	0.47
diaromatic-C14+	0.18	0.15
Total Alkylnaphthalenes	**2.34**	1.87
Cycloaromatics (Indans, Tetralins,etc.)		
cycloaromatic-C09	0.03	0.02
cycloaromatic-C10	0.53	0.44
cycloaromatic-C11	1.46	1.25
cycloaromatic-C12	1.74	1.51
cycloaromatic-C13	1.55	1.36
cycloaromatic-C14	0.94	0.83
cycloaromatics-C15+	0.29	0.25
Total Cycloaromatics	**6.54**	5.67
Total Aromatics	**18.23**	**16.25**
Paraffins		
iso-Paraffins		
C07 & lower -isoparaffins	0.24	0.29
C08-isoparaffins	0.42	0.49
C09-isoparaffins	0.58	0.65
C10-isoparaffins	1.42	1.57
C11-isoparaffins	2.75	2.98
C12-isoparaffins	4.55	4.93
C13-isoparaffins	4.69	4.97
C14-isoparaffins	4.59	4.82
C15-isoparaffins	3.66	3.82
C16-isoparaffins	1.51	1.57
C17-isoparaffins	0.47	0.49
C18-isoparaffins	0.16	0.16
C19-isoparaffins	0.08	0.08
C20-isoparaffins	0.05	0.05
C21-isoparaffins	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01
Total iso-Paraffins	**25.18**	26.87

n-Paraffins		
n-C07 & lower	0.19	0.22
n-C08	0.38	0.43
n-C09	0.55	0.61
n-C10	1.00	1.10
n-C11	2.87	3.12
n-C12	3.13	3.35
n-C13	2.78	2.95
n-C14	2.31	2.43
n-C15	1.41	1.48
n-C16	0.35	0.36
n-C17	0.13	0.13
n-C18	0.04	0.04
n-C19	0.02	0.02
n-C20	<0.01	<0.01
n-C21	<0.01	<0.01
n-C22	<0.01	<0.01
n-C23	<0.01	<0.01
Total n-Paraffins	**15.17**	16.25
Cycloparaffins		
Monocycloparaffins		
C07 & lower monocycloparaffins	0.48	0.50
C08-monocyclocycloparaffins	0.71	0.72
C09-monocyclocycloparaffins	1.50	1.52
C10-monocyclocycloparaffins	2.34	2.29
C11-monocyclocycloparaffins	5.64	5.68
C12-monocyclocycloparaffins	5.36	5.37
C13-monocyclocycloparaffins	5.92	5.86
C14-monocyclocycloparaffins	4.09	4.06
C15-monocyclocycloparaffins	2.65	2.62
C16-monocyclocycloparaffins	0.95	0.94
C17-monocyclocycloparaffins	0.22	0.21
C18-monocyclocycloparaffins	0.06	0.06
C19+-monocyclocycloparaffins	0.03	0.03
Total Monocycloparaffins	**29.94**	29.85
Dicycloparaffins		
C08-dicycloparaffins	0.02	0.02
C09-dicycloparaffins	0.27	0.25
C10-dicycloparaffins	0.71	0.63
C11-dicycloparaffins	2.33	2.19
C12-dicycloparaffins	2.63	2.48
C13-dicycloparaffins	3.01	2.84
C14-dicycloparaffins	1.80	1.70
C15-dicycloparaffins	0.57	0.54
C16-dicycloparaffins	0.04	0.04
C17+-dicycloparaffins	0.02	0.02
Total Dicycloparaffins	**11.40**	10.72
Tricycloparaffins		
C10-tricycloparaffins	<0.01	<0.01
C11-tricycloparaffins	0.07	0.06
C12-tricycloparaffins	<0.01	<0.01
Total Tricycloparaffins	**0.07**	0.06
Total Cycloparaffins	**41.42**	40.63
Average Molecular Formula - C	12.1	
Average Molecular Formula - H	23.2	

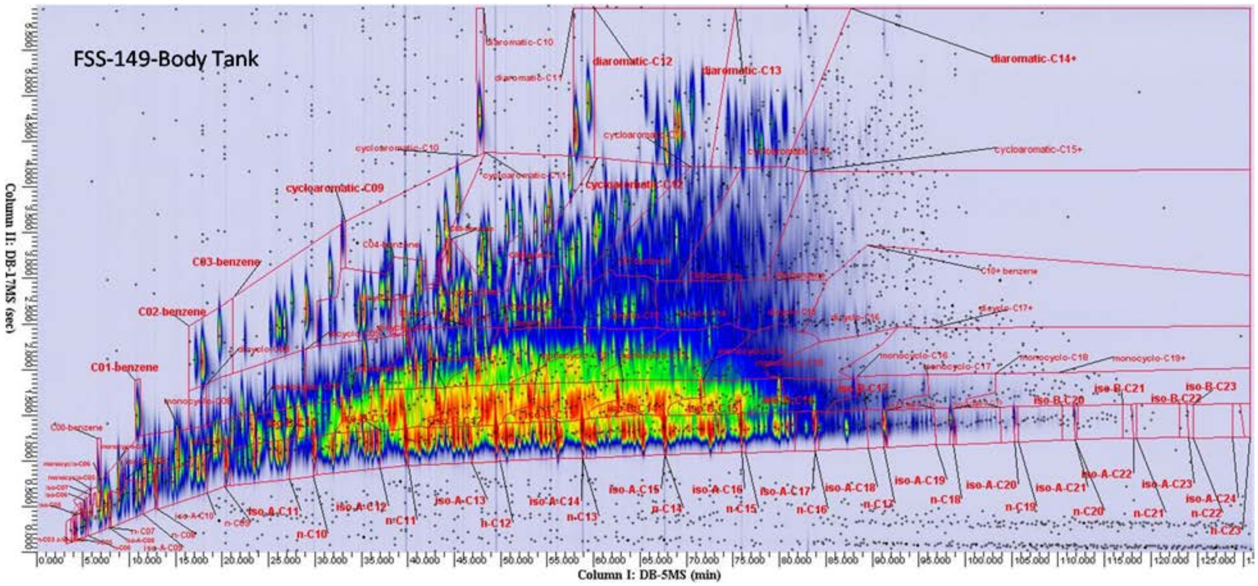


Figure F- 11 GCxGC Summary Fuel From Body Tank, End of Runt

Table F- 3 GCxGC Tabulated Data - Fuel From Body Tank, End Of Run

GCxGC Summary		
Hydrogen content (weight %)	13.9	
Average Molecular Wt (g/mole)	168	
	FSS149-Body Tank	
	Weight %	Volume %
Aromatics		
Alkylbenzenes		
benzene (C06)	<0.01	<0.01
toluene (C07)	0.10	0.10
C2-benzene (C08)	0.42	0.39
C3-benzene (C09)	0.87	0.81
C4-benzene (C10)	1.47	1.37
C5-benzene (C11)	1.78	1.65
C6-benzene (C12)	1.67	1.56
C7-benzene (C13)	1.24	1.16
C8-benzene (C14)	0.99	0.93
C9-benzene (C15)	0.59	0.55
C10+-benzene (C16+)	0.23	0.21
Total Alkylbenzenes	**9.37**	8.73
Diaromatics (Naphthalenes, Biphenyls, etc.)		
diaromatic-C10	0.11	0.09
diaromatic-C11	0.50	0.40
diaromatic-C12	0.95	0.77
diaromatic-C13	0.59	0.48
diaromatic-C14+	0.17	0.14
Total Alkylnaphthalenes	**2.33**	1.87
Cycloaromatics (Indans, Tetralins,etc.)		
cycloaromatic-C09	0.03	0.02
cycloaromatic-C10	0.53	0.44
cycloaromatic-C11	1.52	1.30
cycloaromatic-C12	1.68	1.46
cycloaromatic-C13	1.53	1.34
cycloaromatic-C14	0.96	0.84
cycloaromatics-C15+	0.28	0.25
Total Cycloaromatics	**6.53**	5.65
Total Aromatics	**18.23**	**16.25**
Paraffins		
iso-Paraffins		
C07 & lower -isoparaffins	0.24	0.29
C08-isoparaffins	0.43	0.49
C09-isoparaffins	0.58	0.66
C10-isoparaffins	1.48	1.63
C11-isoparaffins	2.77	2.99
C12-isoparaffins	4.53	4.90
C13-isoparaffins	4.72	5.00
C14-isoparaffins	4.58	4.82
C15-isoparaffins	3.64	3.80
C16-isoparaffins	1.52	1.58
C17-isoparaffins	0.46	0.47
C18-isoparaffins	0.15	0.15
C19-isoparaffins	0.07	0.07
C20-isoparaffins	0.04	0.05
C21-isoparaffins	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01
Total iso-Paraffins	**25.20**	26.89

n-Paraffins		
n-C07 & lower	0.19	0.22
n-C08	0.38	0.43
n-C09	0.56	0.62
n-C10	1.03	1.13
n-C11	2.89	3.13
n-C12	3.11	3.32
n-C13	2.78	2.95
n-C14	2.34	2.46
n-C15	1.41	1.47
n-C16	0.34	0.36
n-C17	0.13	0.14
n-C18	0.04	0.04
n-C19	0.02	0.02
n-C20	<0.01	<0.01
n-C21	<0.01	<0.01
n-C22	<0.01	<0.01
n-C23	<0.01	<0.01
Total n-Paraffins	**15.23**	16.31
Cycloparaffins		
Monocycloparaffins		
C07 & lower monocycloparaffins	0.48	0.50
C08-monocyclocycloparaffins	0.71	0.72
C09-monocyclocycloparaffins	1.47	1.49
C10-monocyclocycloparaffins	2.30	2.26
C11-monocyclocycloparaffins	5.57	5.60
C12-monocyclocycloparaffins	5.53	5.53
C13-monocyclocycloparaffins	5.82	5.76
C14-monocyclocycloparaffins	4.06	4.03
C15-monocyclocycloparaffins	2.59	2.56
C16-monocyclocycloparaffins	0.94	0.93
C17-monocyclocycloparaffins	0.19	0.19
C18-monocyclocycloparaffins	0.08	0.08
C19+-monocyclocycloparaffins	0.03	0.03
Total Monocycloparaffins	**29.78**	29.69
Dicycloparaffins		
C08-dicycloparaffins	0.02	0.02
C09-dicycloparaffins	0.30	0.27
C10-dicycloparaffins	0.71	0.64
C11-dicycloparaffins	2.42	2.27
C12-dicycloparaffins	2.60	2.46
C13-dicycloparaffins	2.88	2.72
C14-dicycloparaffins	1.88	1.77
C15-dicycloparaffins	0.61	0.57
C16-dicycloparaffins	0.04	0.04
C17+-dicycloparaffins	0.03	0.03
Total Dicycloparaffins	**11.48**	10.79
Tricycloparaffins		
C10-tricycloparaffins	<0.01	<0.01
C11-tricycloparaffins	0.07	0.06
C12-tricycloparaffins	<0.01	<0.01
Total Tricycloparaffins	**0.07**	0.06
Total Cycloparaffins	**41.33**	40.54
Average Molecular Formula - C	12.1	
Average Molecular Formula - H	23.2	

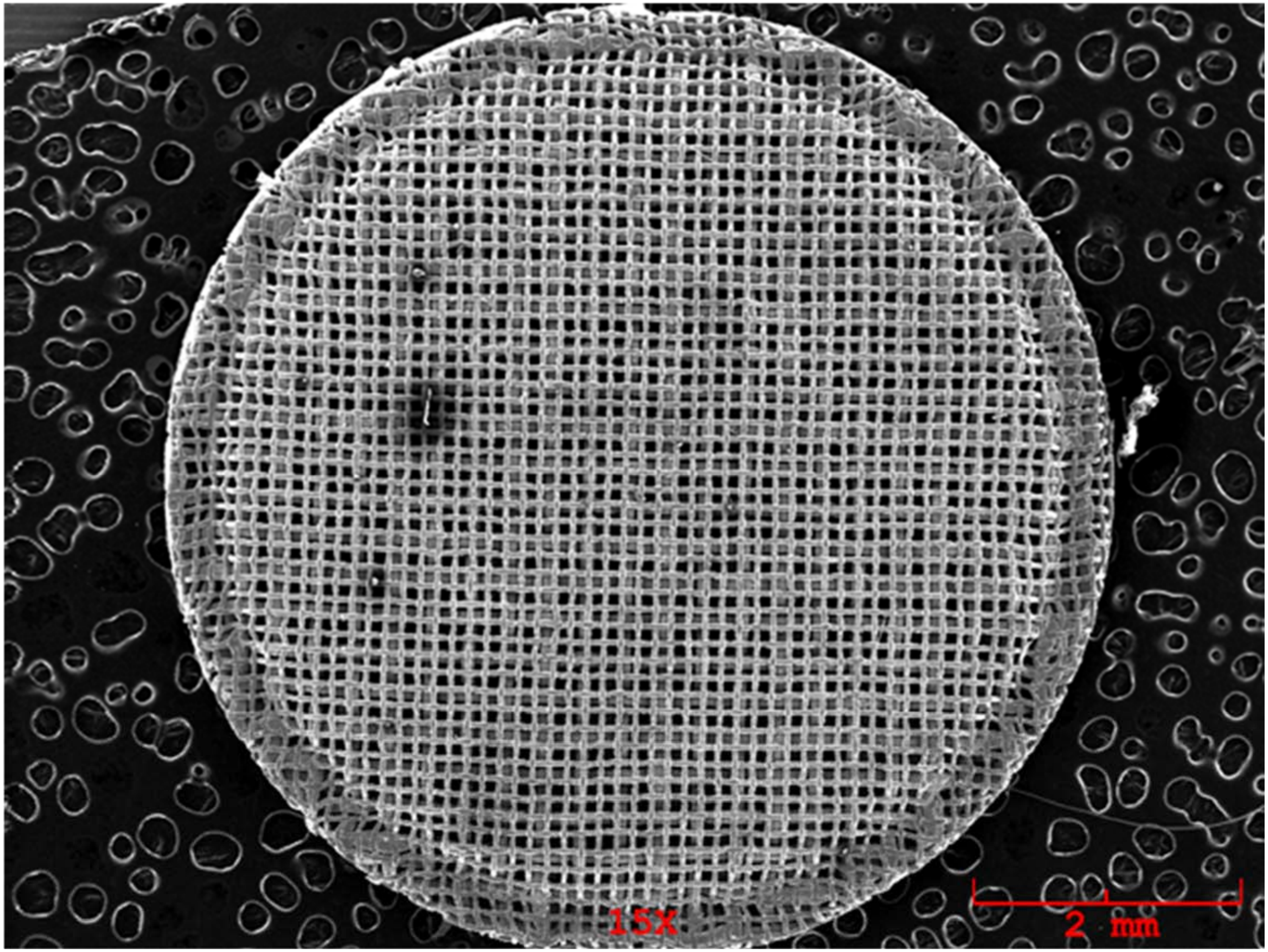
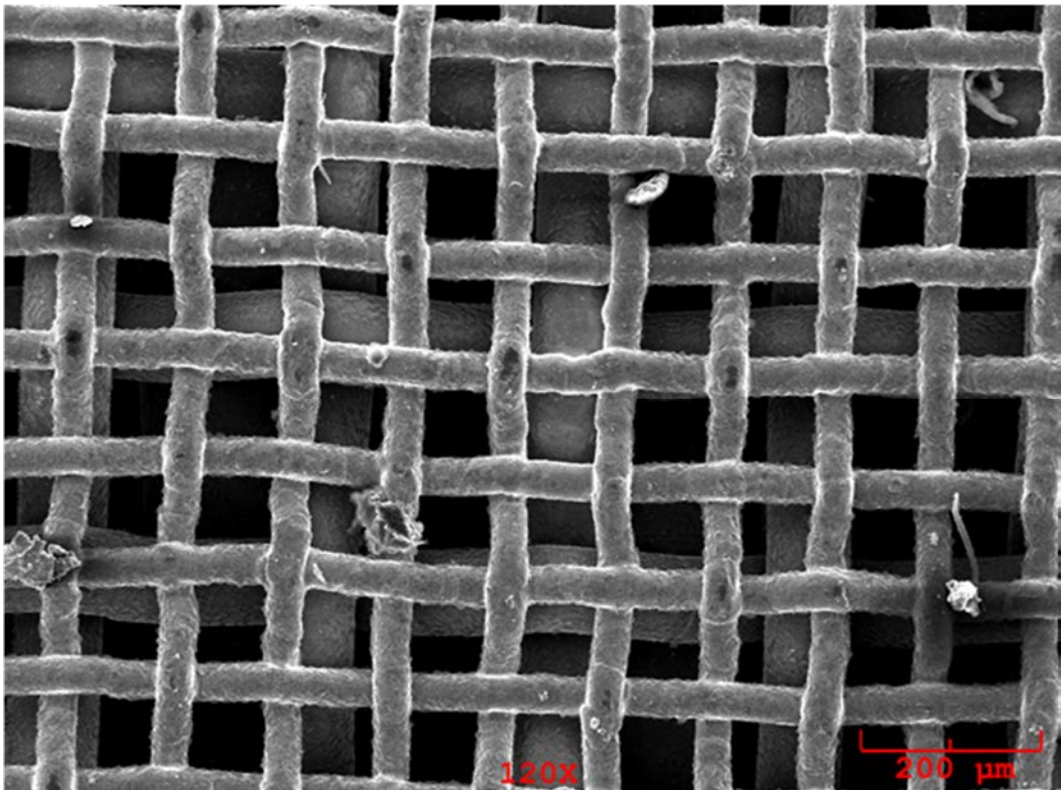


Figure F- 12 TMS Screen, Top, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
O	Ka	3.57	1.037	wt.%	0.139	0.176	
Al	Ka	5.24	1.108	wt.%	0.122	0.154	
Si	Ka	2.96	0.507	wt.%	0.096	0.132	
S	Ka	11.10	1.489	wt.%	0.096	0.111	
Cr	Ka	94.56	17.681	wt.%	0.275	0.147	
Mn	Ka	6.41	1.627	wt.%	0.160	0.202	
Fe	Ka	220.43	67.375	wt.%	0.660	0.235	
Ni	Ka	16.88	7.705	wt.%	0.323	0.281	
Cu	Ka	2.61	1.471	wt.%	0.241	0.313	
			100.000	wt.%			Total

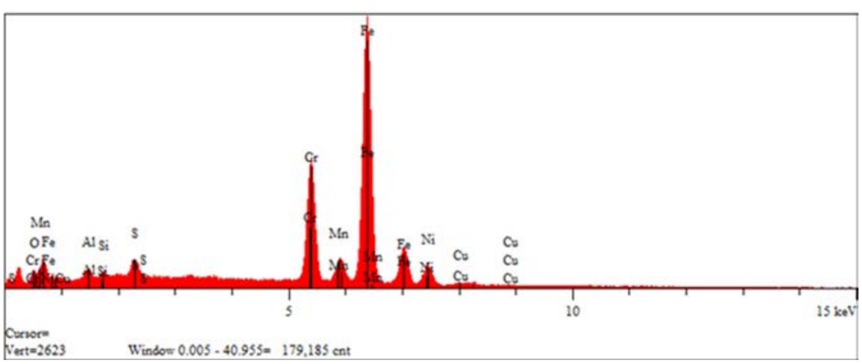


Figure F- 13 TMS Screen Top, 120X and EDX Elemental Analysis

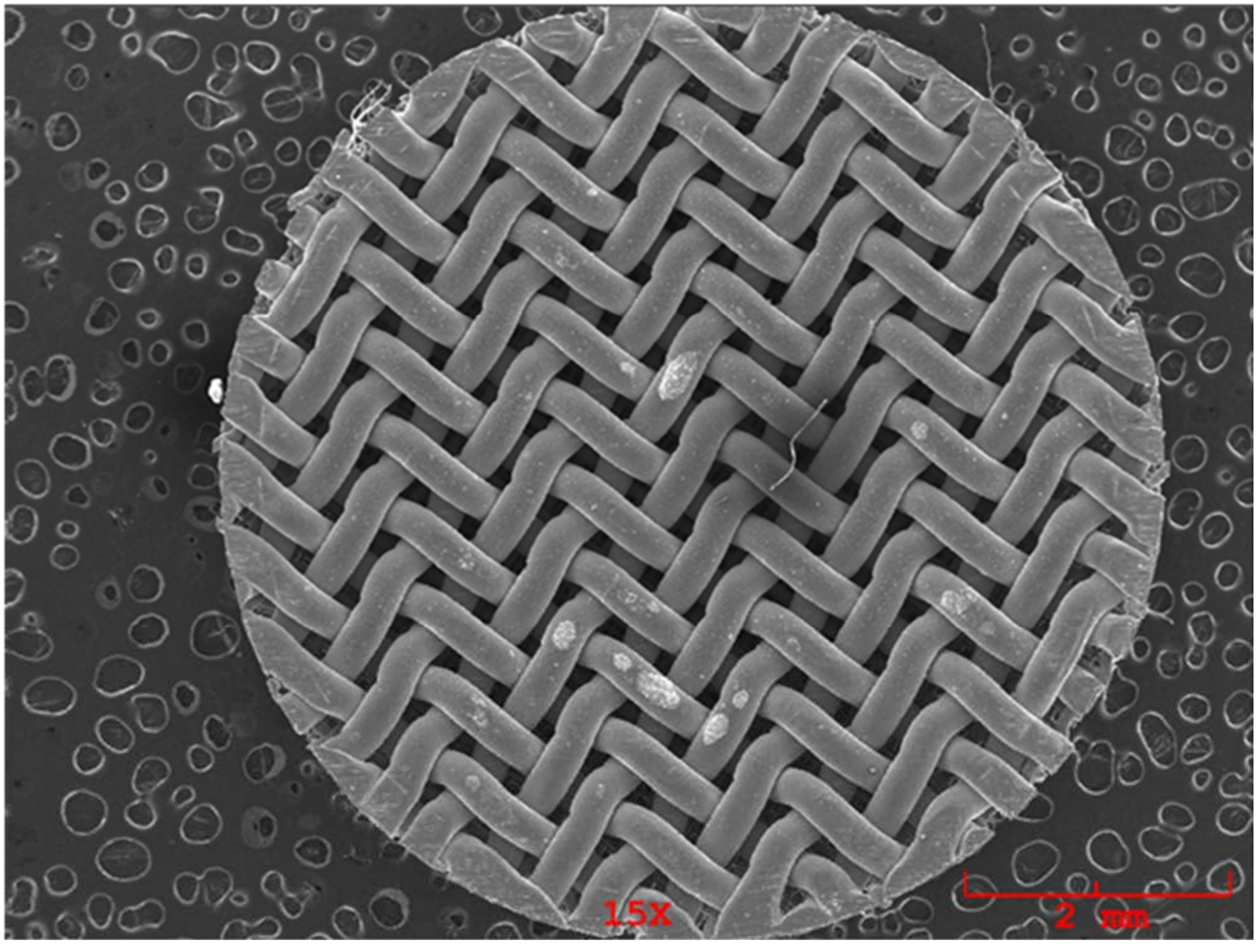
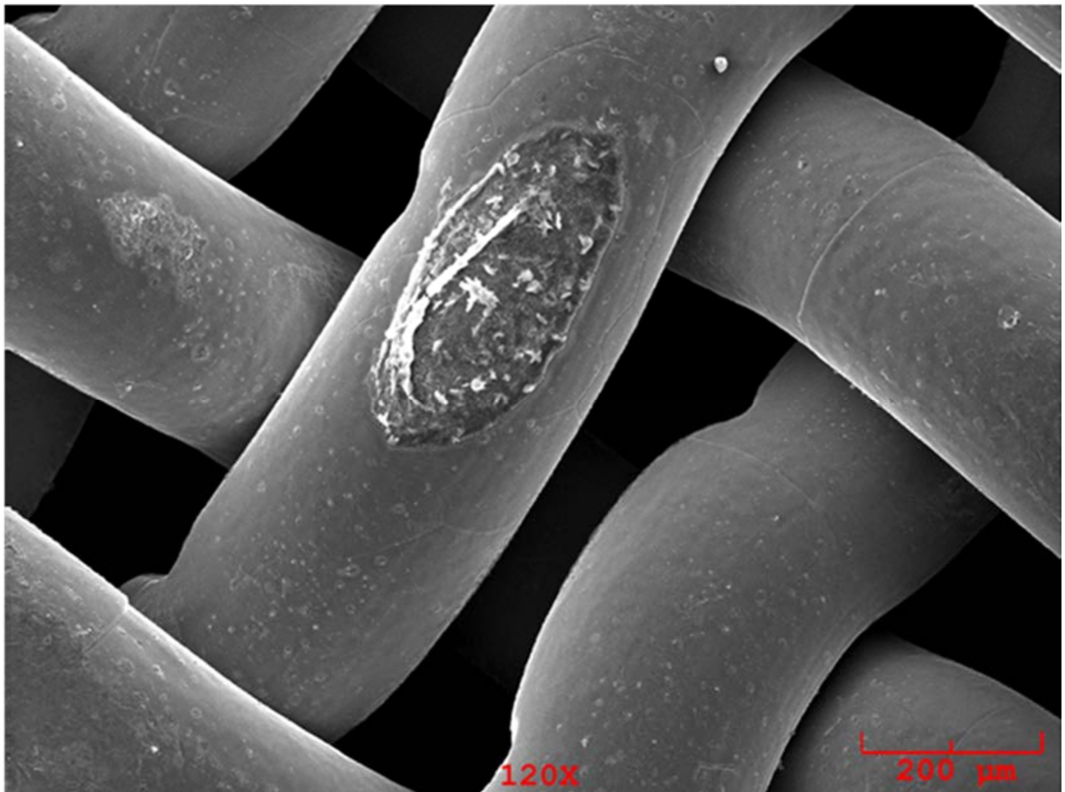


Figure F- 14 TMS Screen, Bottom, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
Al	Ka	3.51	0.533	wt.%	0.093	0.129	
Si	Ka	4.81	0.553	wt.%	0.077	0.105	
S	Ka	11.37	0.913	wt.%	0.066	0.081	
Cr	Ka	219.20	18.140	wt.%	0.183	0.090	
Fe	Ka	527.02	70.401	wt.%	0.443	0.142	
Ni	Ka	48.26	9.460	wt.%	0.226	0.180	
			100.000	wt.%			Total

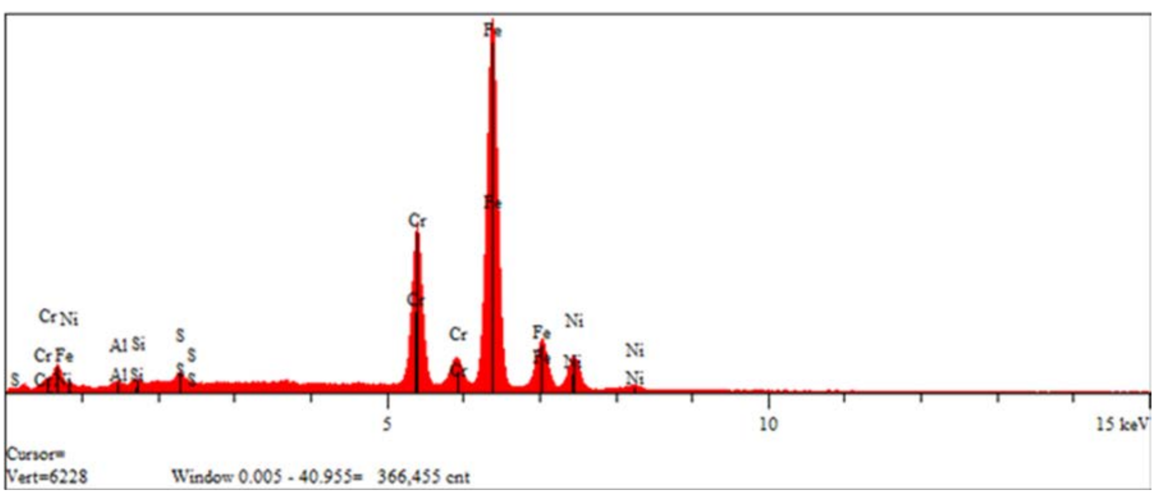


Figure F- 15 TMS Screen, Bottom, 120X and EDX Elemental Analysis

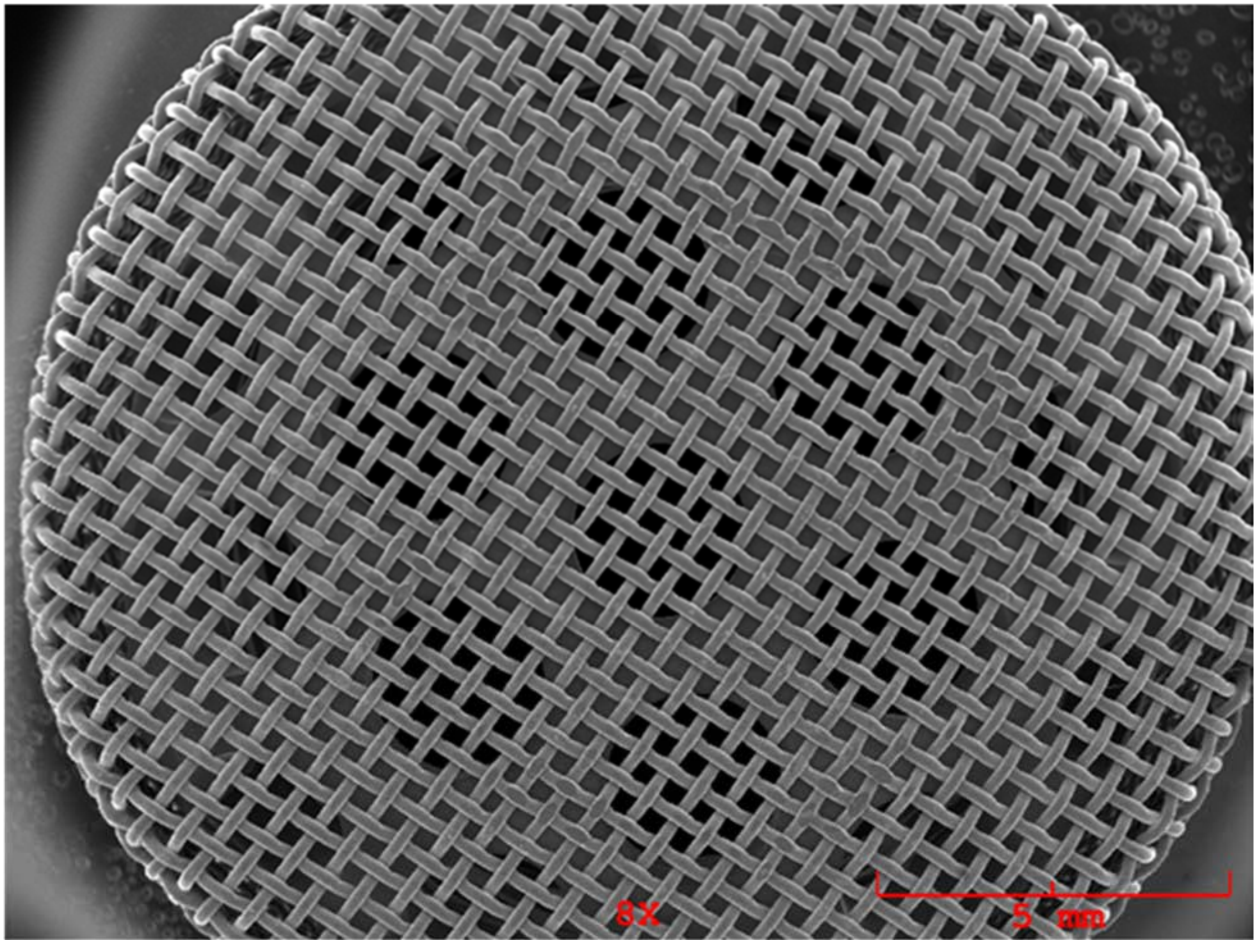
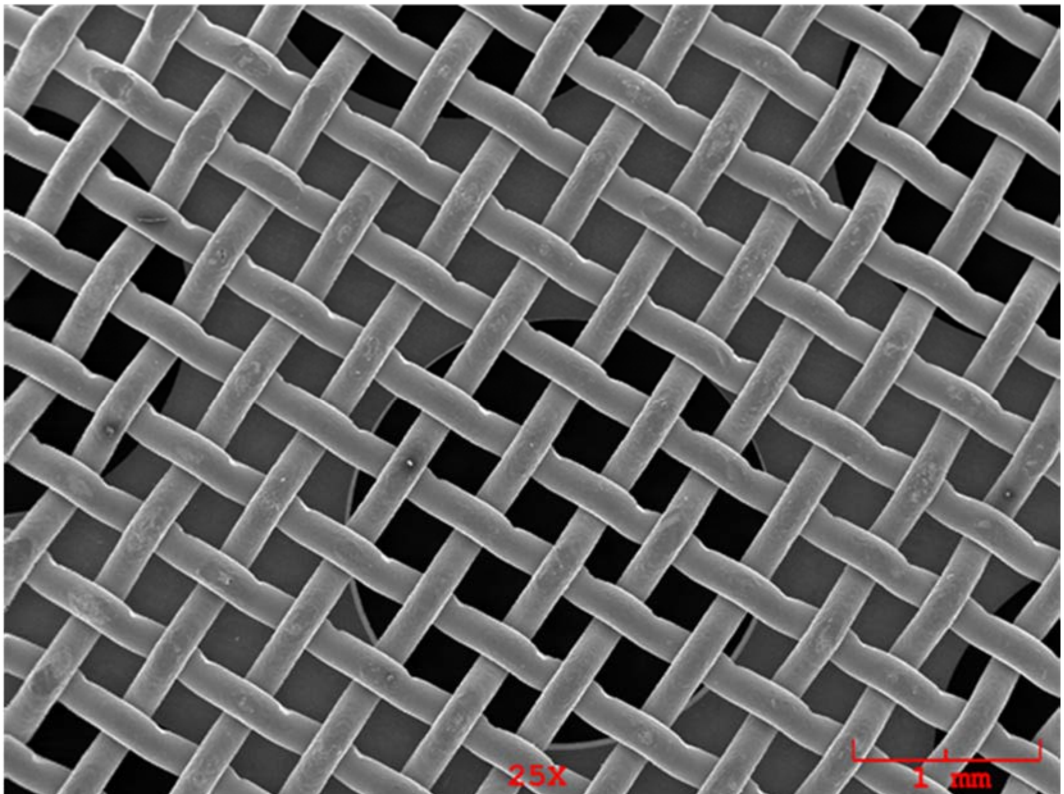


Figure F- 16 F303 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
Si	Ka	4.09	0.505	wt.%	0.092	0.128	
S	Ka	12.34	1.190	wt.%	0.088	0.110	
Cr	Ka	125.95	16.428	wt.%	0.240	0.150	
Fe	Ka	328.59	71.708	wt.%	0.615	0.257	
Ni	Ka	31.00	10.169	wt.%	0.342	0.314	
			100.000	wt.%			Total

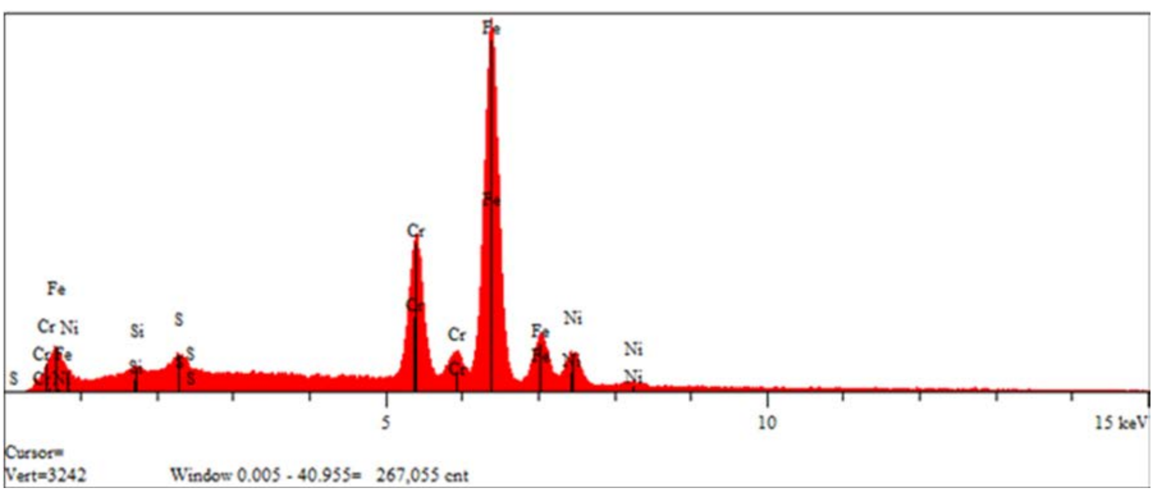


Figure F- 17 F303 Bottom 25X and EDX Elemental Analysis

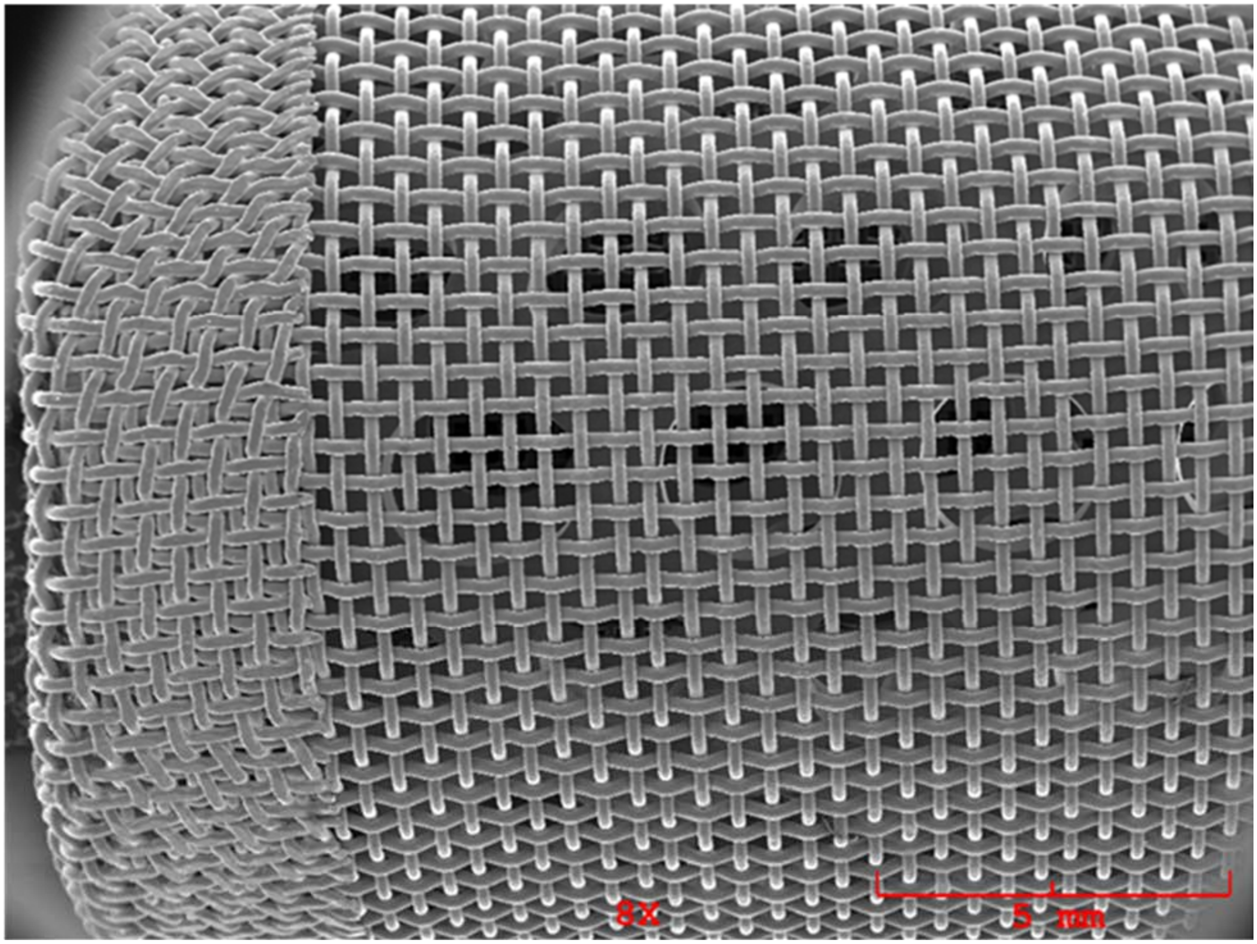
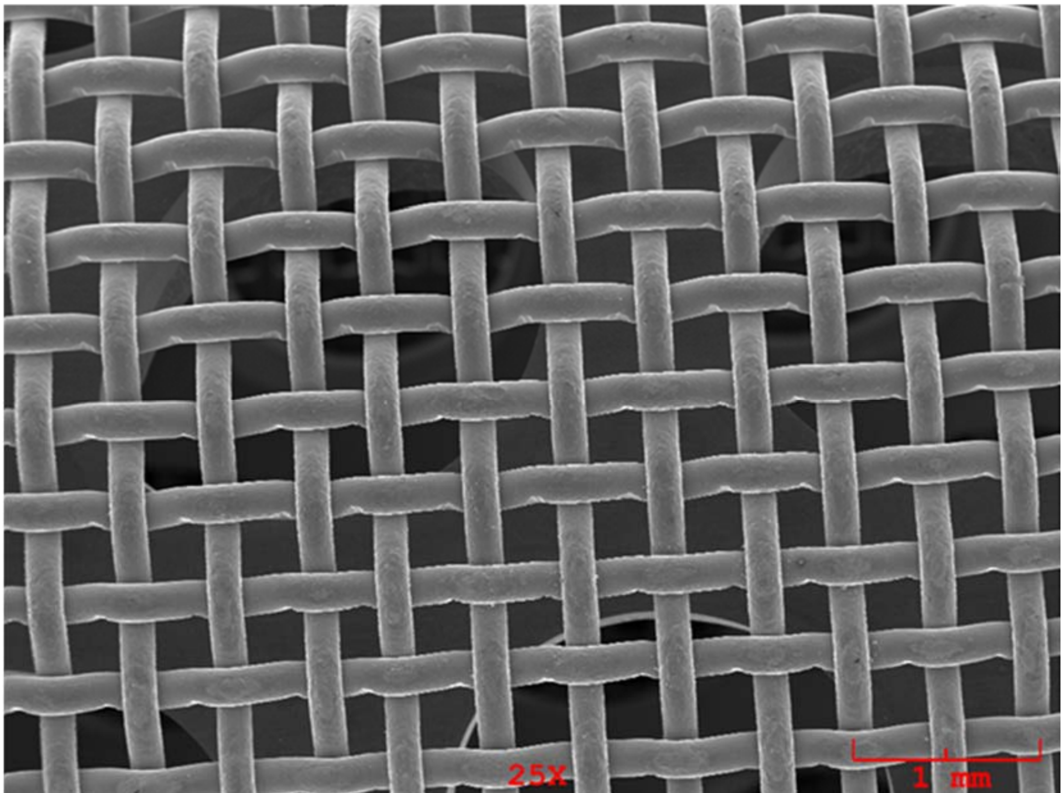


Figure F- 18 F303 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
Si	Ka	3.09	0.421	wt.%	0.130	0.184	
S	Ka	10.50	1.117	wt.%	0.124	0.157	
Cr	Ka	115.25	16.583	wt.%	0.337	0.207	
Fe	Ka	299.53	72.230	wt.%	0.866	0.351	
Ni	Ka	26.63	9.649	wt.%	0.479	0.458	
			100.000	wt.%			Total

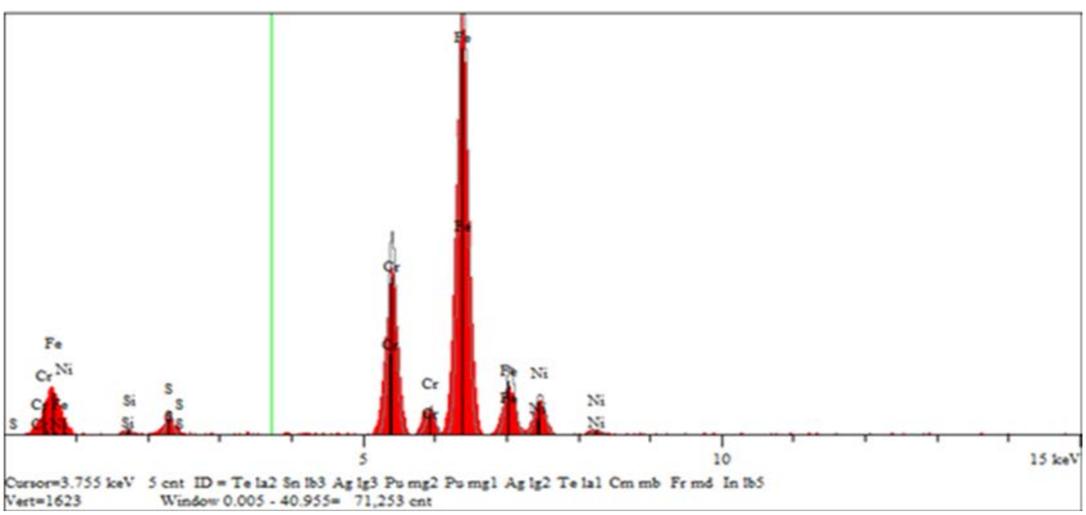


Figure F- 19 F303 Side 25X and EDX Elemental Analysis

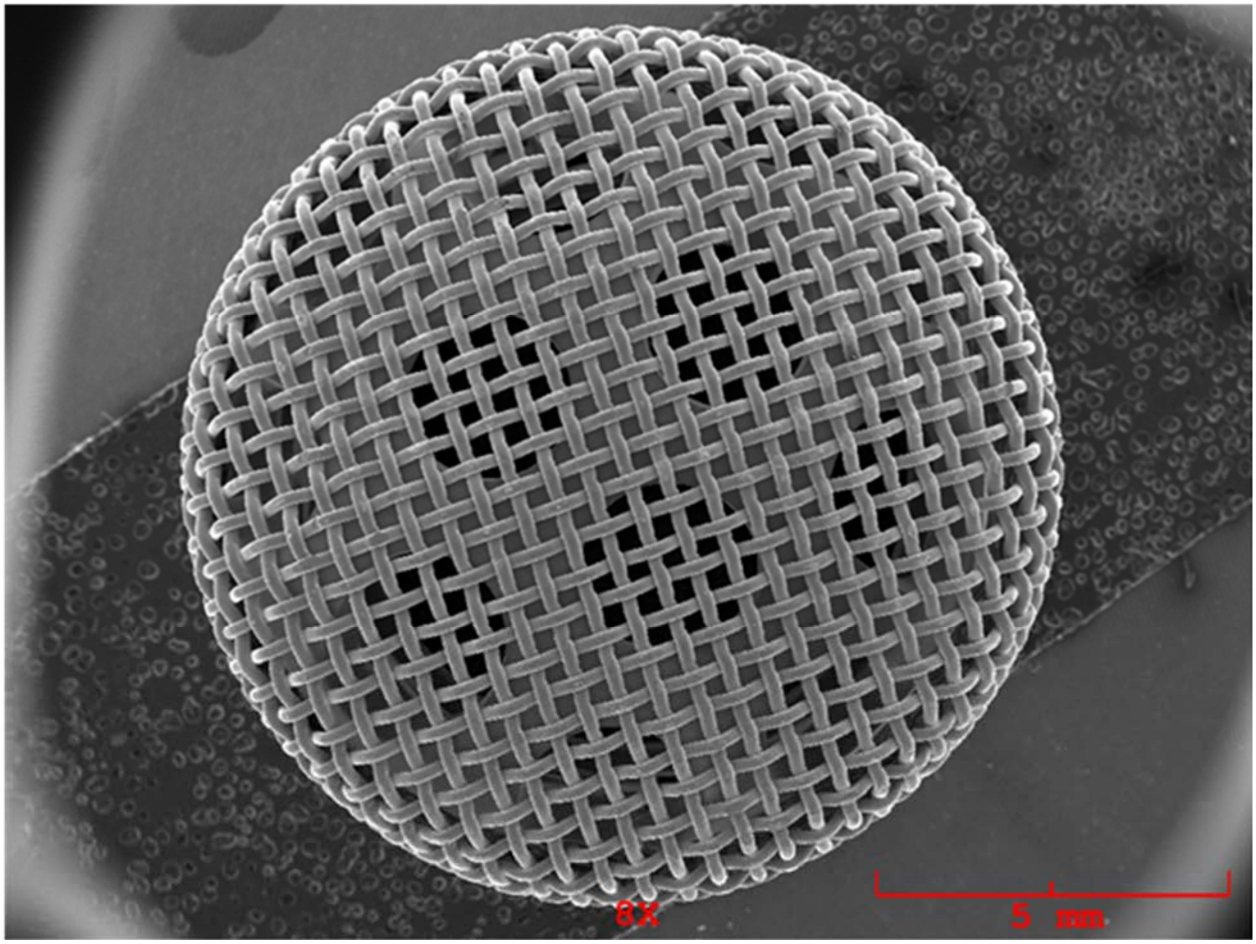
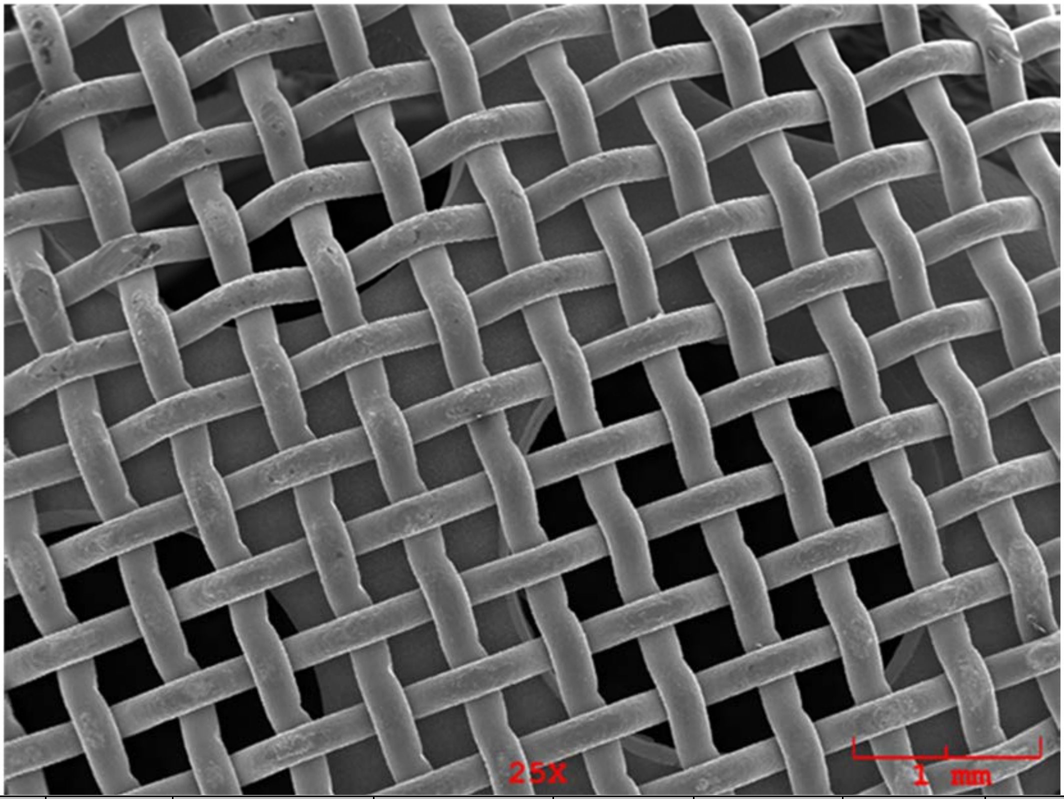


Figure F- 20 F304 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
Si	Ka	2.99	0.416	wt.%	0.130	0.185	
S	Ka	10.53	1.144	wt.%	0.123	0.155	
Cr	Ka	111.31	16.333	wt.%	0.338	0.208	
Fe	Ka	293.32	72.175	wt.%	0.876	0.365	
Ni	Ka	26.85	9.933	wt.%	0.480	0.442	
			100.000	wt.%			Total

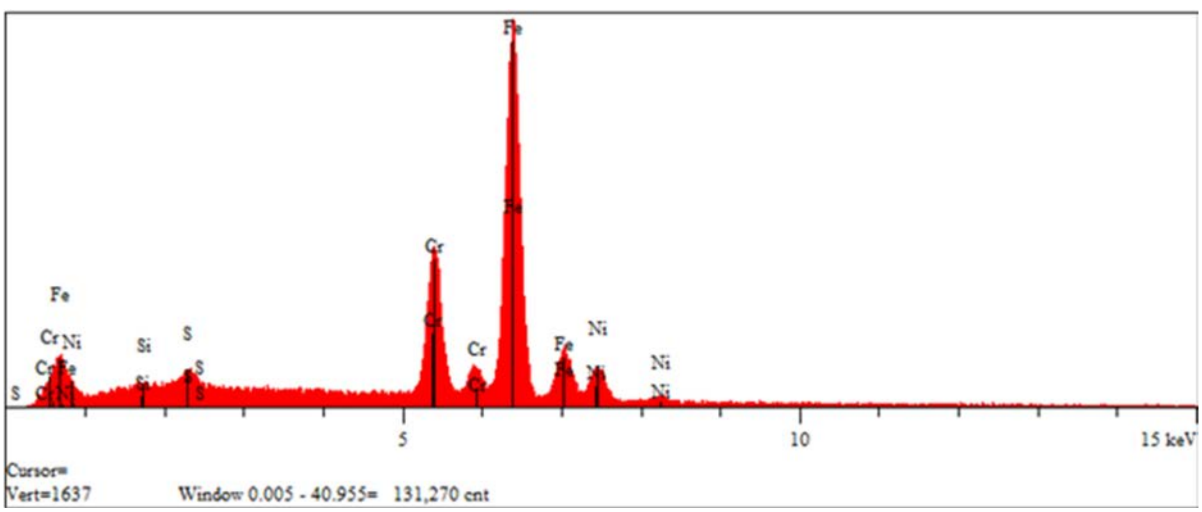


Figure F- 21 F304 Bottom, 25X and EDX Elemental Analysis

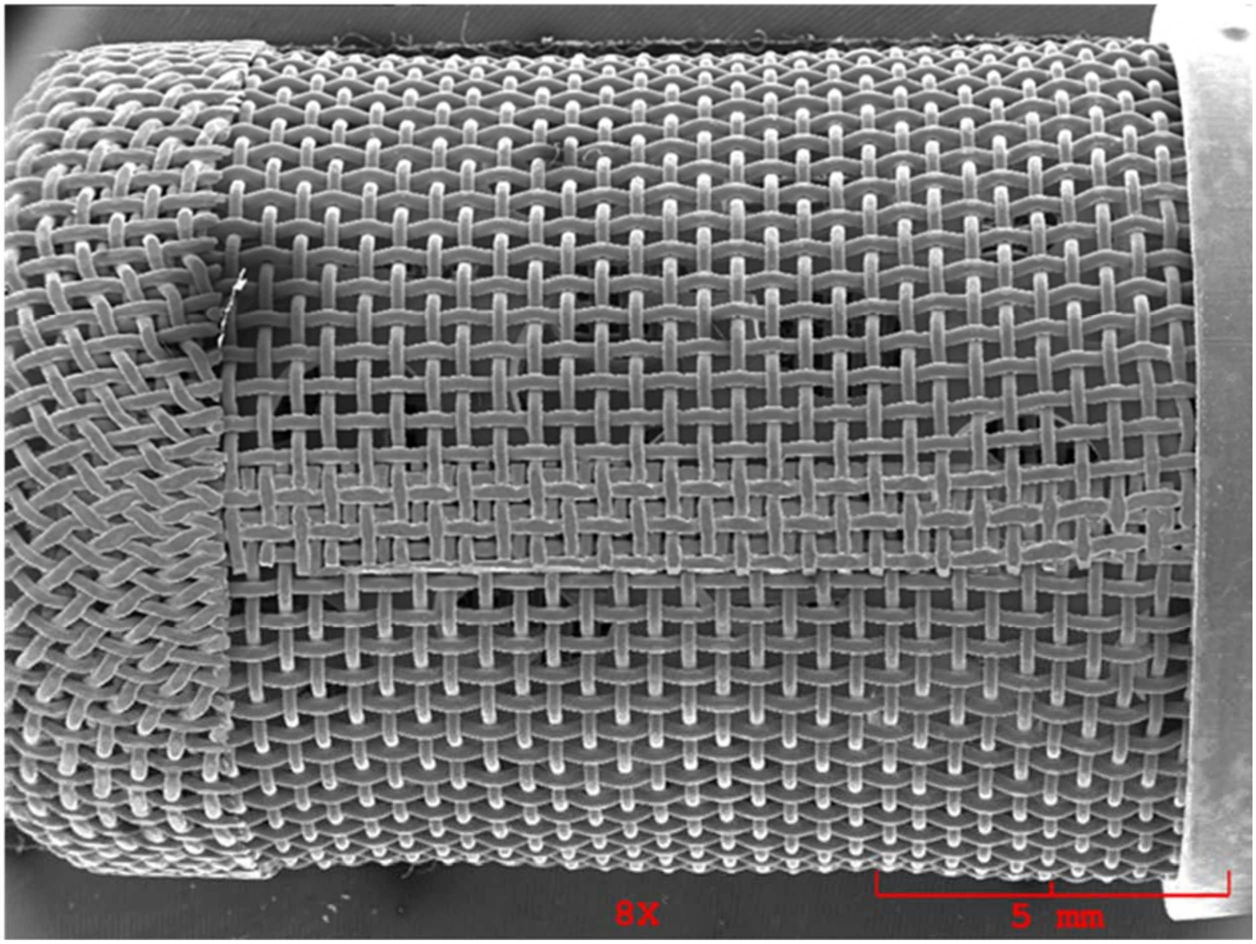
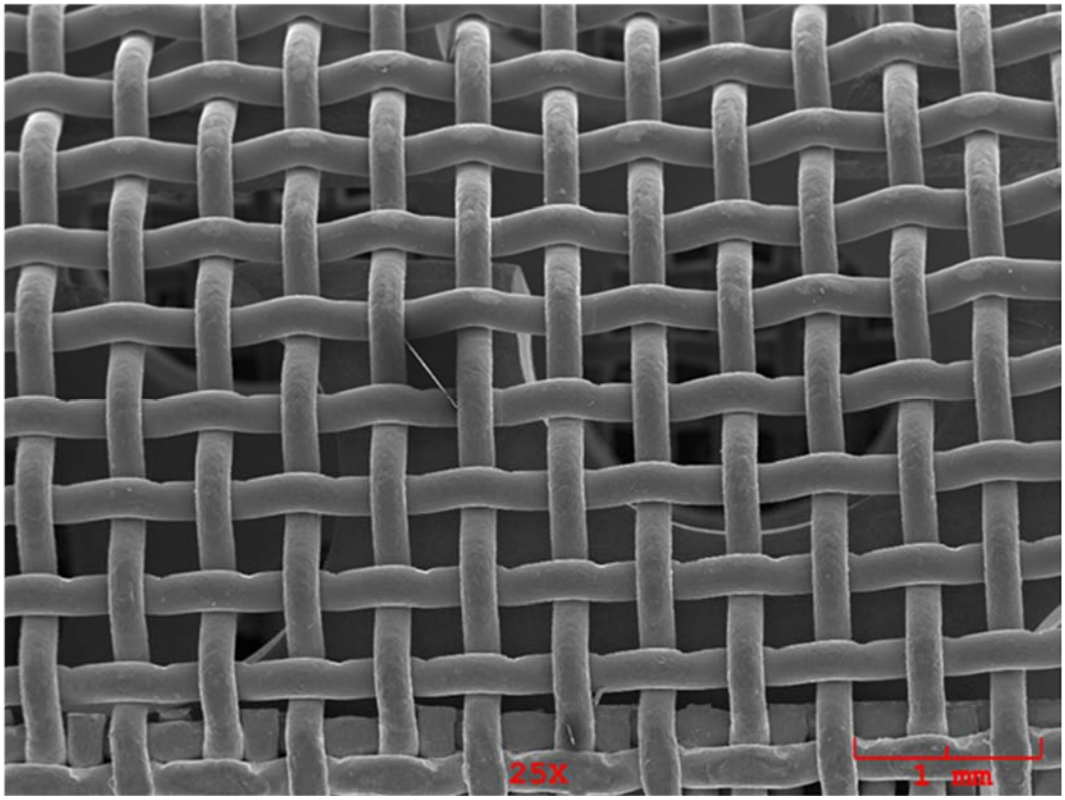


Figure F- 22 F304 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
Si	Ka	2.91	0.401	wt.%	0.132	0.188	
S	Ka	10.24	1.101	wt.%	0.124	0.158	
Cr	Ka	112.60	16.357	wt.%	0.338	0.212	
Fe	Ka	294.80	71.681	wt.%	0.868	0.366	
Ni	Ka	28.61	10.461	wt.%	0.482	0.431	
			100.000	wt.%			Total

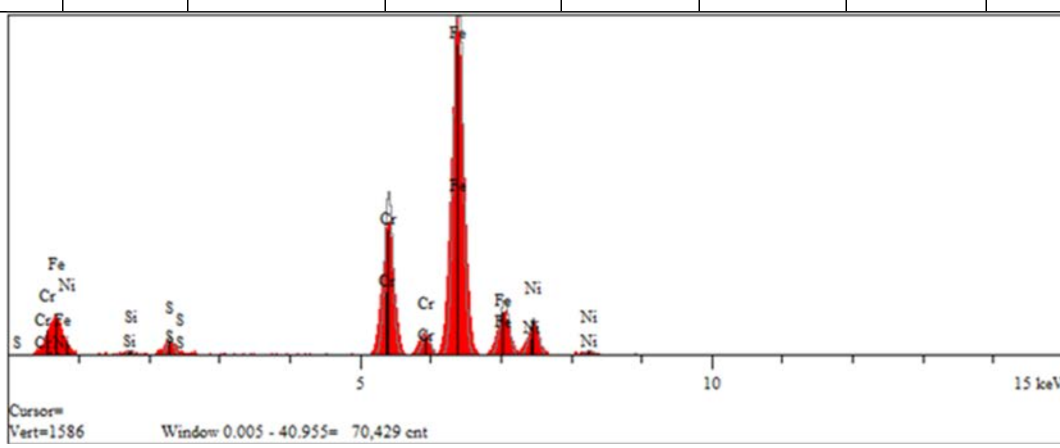


Figure F- 23 F304 Side, 25X and EDX Elemental Analysis

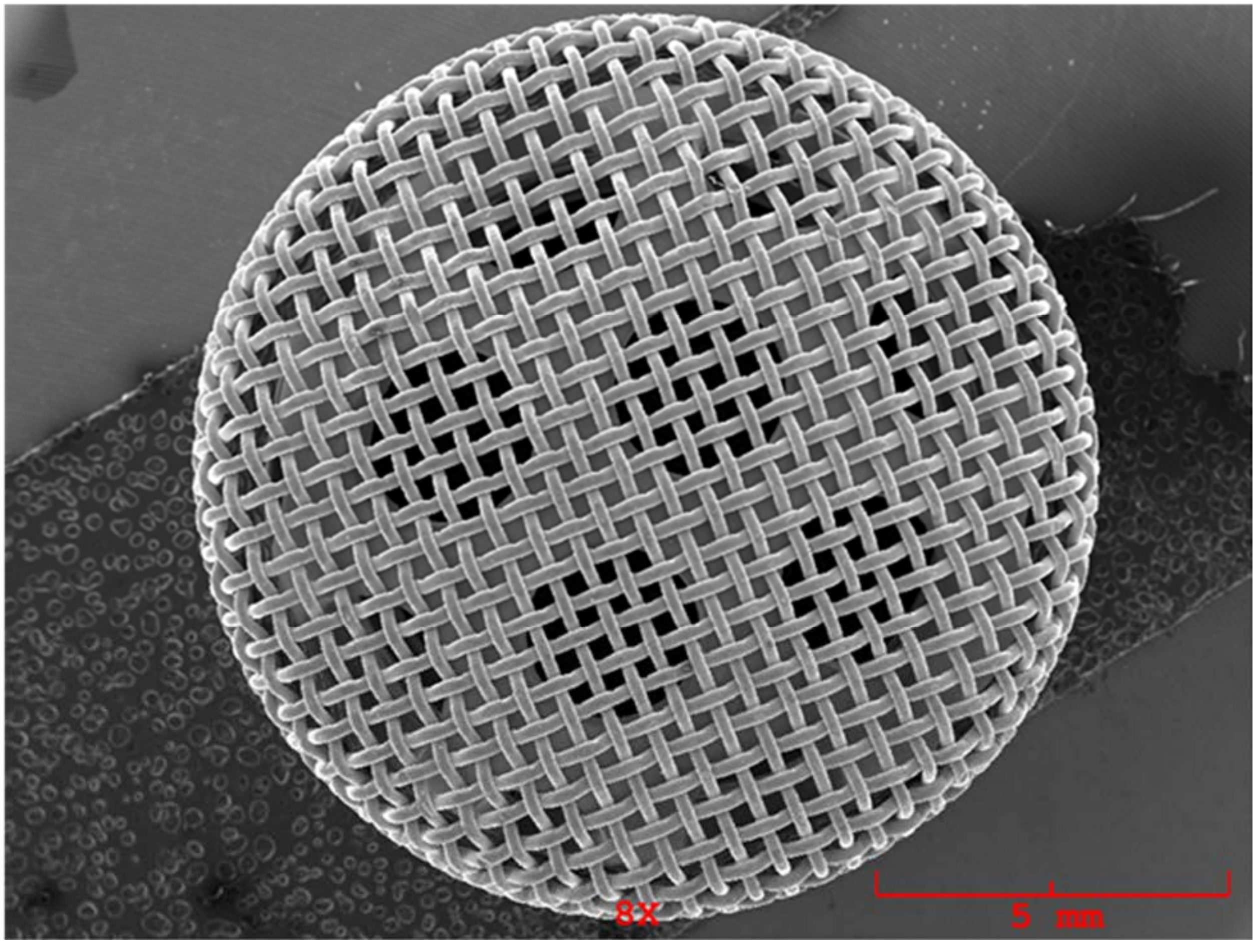
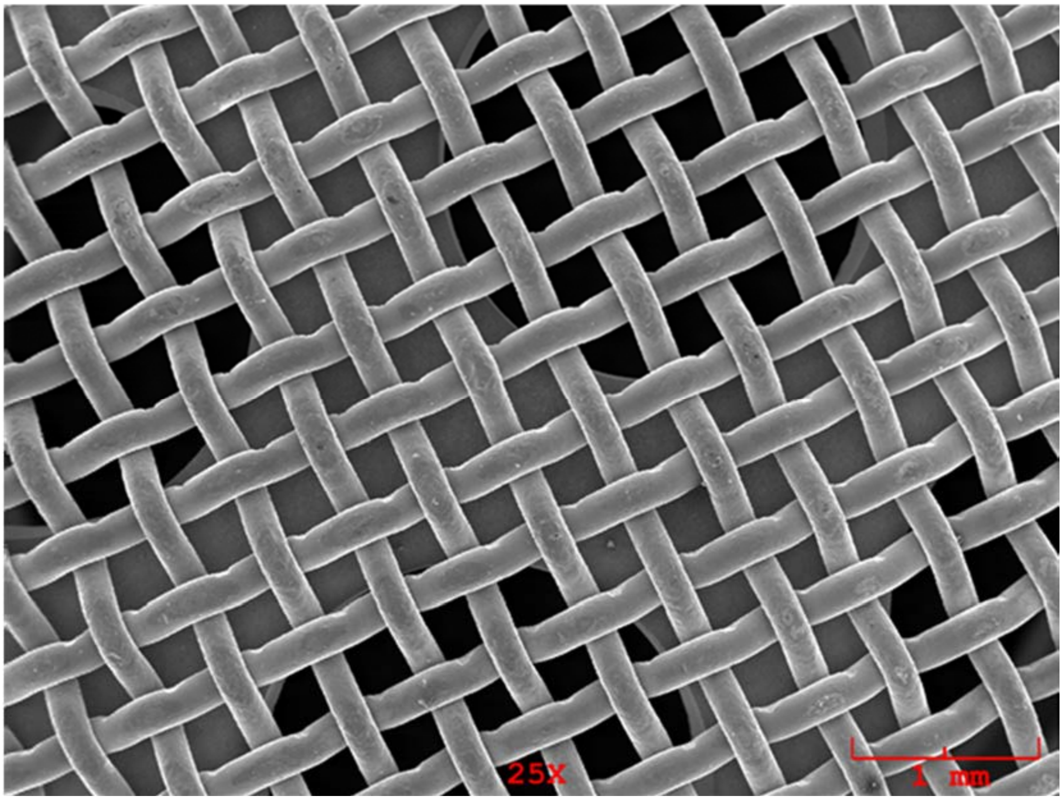


Figure F- 24 F702 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
Si	Ka	2.98	0.418	wt.%	0.129	0.183	
S	Ka	9.97	1.093	wt.%	0.125	0.160	
Cr	Ka	109.42	16.160	wt.%	0.339	0.213	
Fe	Ka	291.97	72.420	wt.%	0.882	0.372	
Ni	Ka	26.56	9.909	wt.%	0.491	0.466	
			100.000	wt.%			Total

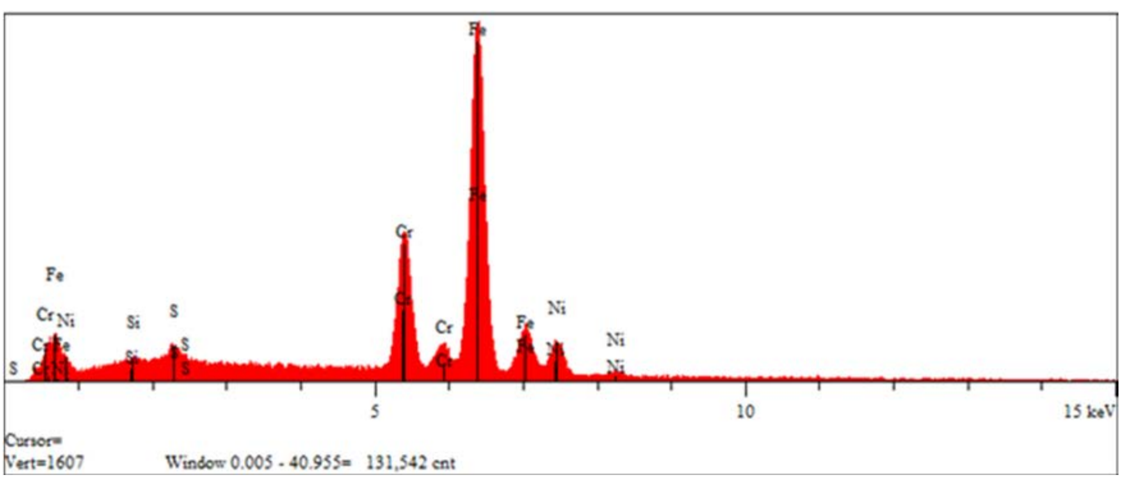


Figure F- 25 F702 Bottom, 25X and EDX Elemental Analysis

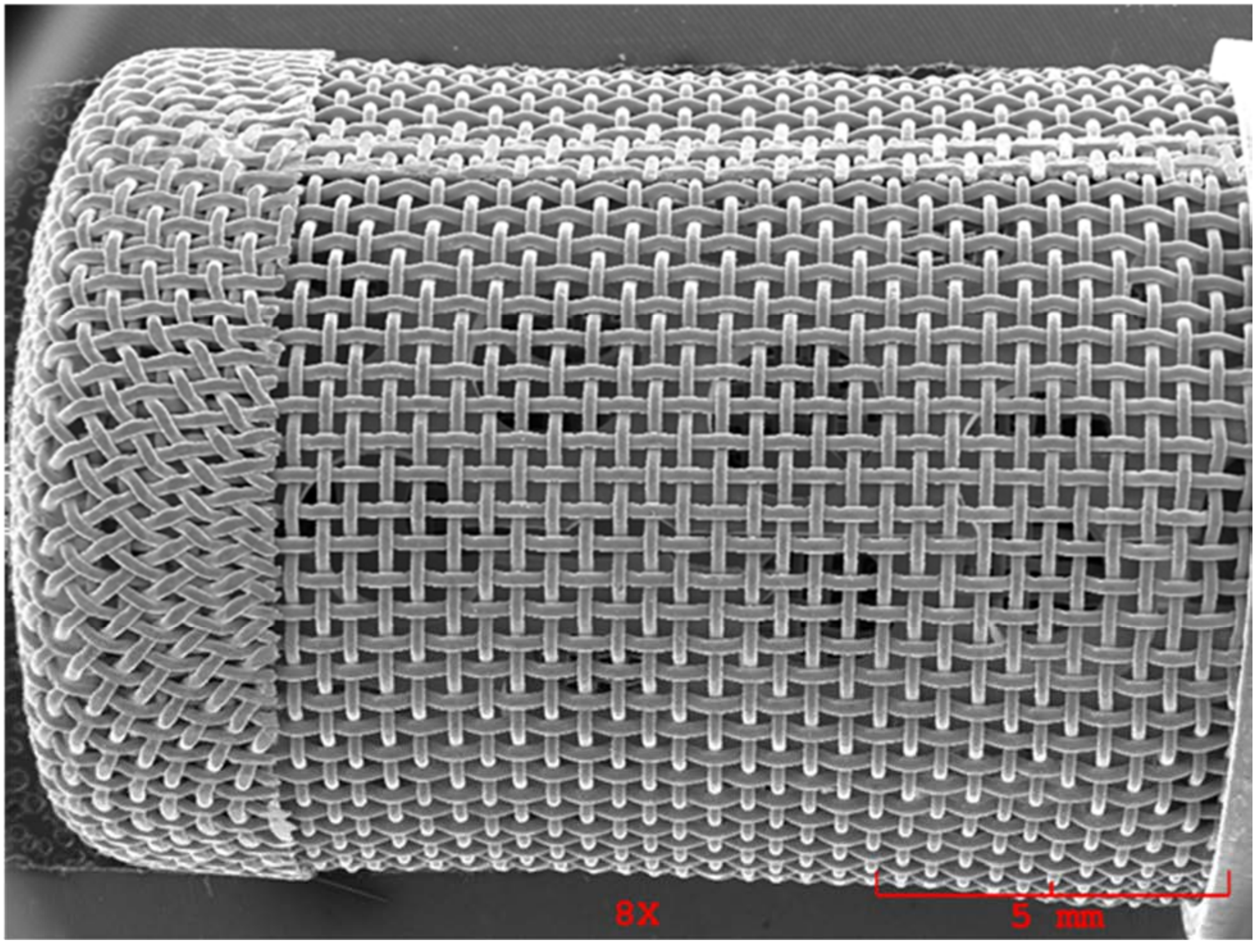
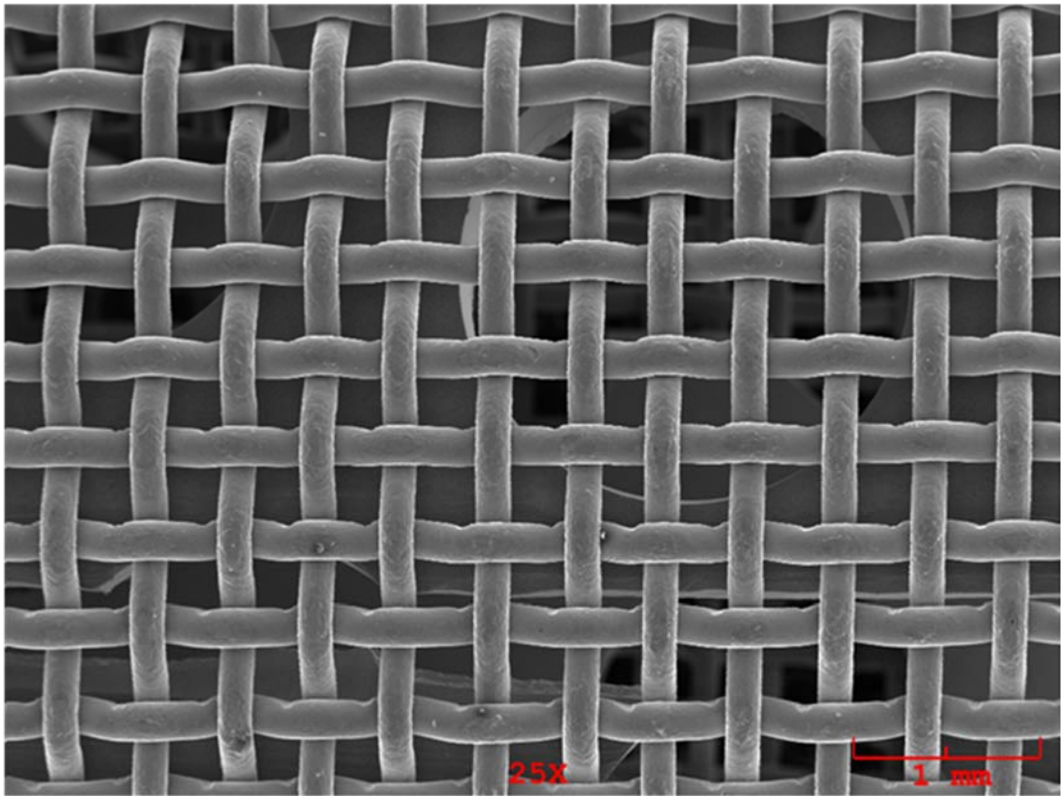


Figure F- 26 F702 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
Si	Ka	2.14	0.338	wt.%	0.139	0.200	
S	Ka	11.80	1.456	wt.%	0.137	0.164	
Cr	Ka	97.74	16.340	wt.%	0.361	0.223	
Fe	Ka	256.54	71.755	wt.%	0.930	0.383	
Ni	Ka	24.05	10.111	wt.%	0.522	0.491	
			100.000	wt.%			Total

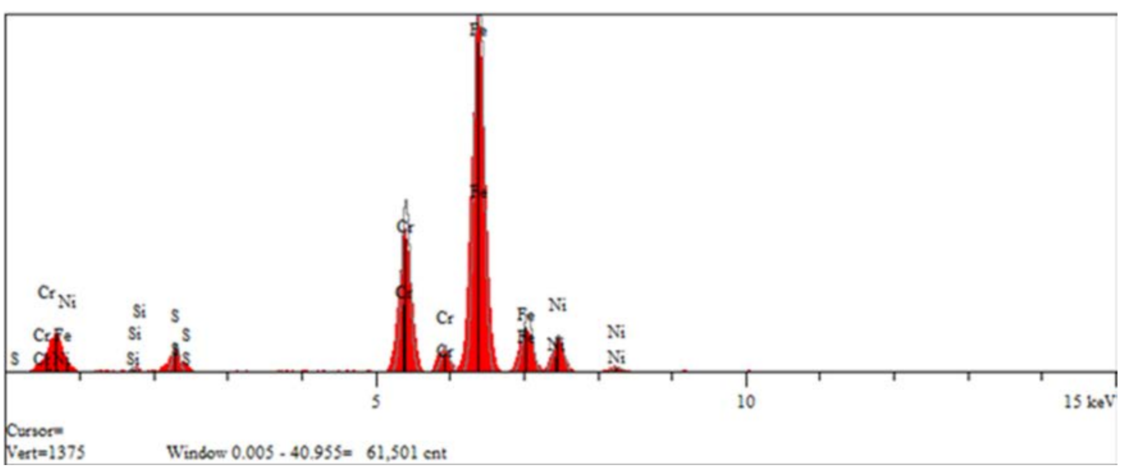


Figure F-27 F702 Side, 25X and EDX Elemental Analysis

APPENDIX G - RUN 150 DATA PACKAGE

Run Conditions: EDTST Mode, MT Conditions
Fuel ID: POSF-12831, Gulf Coast Jet A
Airframe Heat Exchanger Bulk Fuel Output: 285 °F
HP Pump HX Out/FCOC Bulk Fuel In: 325 °F
Fuel-Cooled Oil Cooler Bulk Fuel Output: 350 °F
Burner Feed Arm Max Wetted Wall Temperature: 510 °F
Run Duration: 72 Hours

DATA SUMMARY

Run 150; Run Type: EDTST; Op Mode: MT; MSNs: N/A; EDTST Run Hours: 72 Fuel ID#: POSF-12831; Run Tank: S-15; Run Type: EDTST; Op Mode: MT Fuel Type: Jet A; Additive(s): None AFHX Out: 285 °F; FCOC In: 325 °F; FCOC Out: 350 °F; BFA MWWT: 510 °F;

Component/Device	Serial No.	Pre-Test %	Post-Test %	Spread (Pre/Post Delta), %	Shift, PPH	Skew, PSID	Flow Range Shift, PPH	Flow Midpoint Shift, PPH	Overall Rating	Hysteresis Area Change (PPH-DP)
FDV	1248	1.9	1.3	-0.5	-1.4	0.2	-1.3	-0.6	None	-8
Servo2	028	3.3	4.3	1.0	-1.5	-0.5	-0.1	-0.1	Minor	69

Effective Carbon - µgrams

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	50.6	40.3	31.0	24.8	38.2					
BFA	66.1	110.8	178.5	273.2	311.4	408.8	456.1	442.8	375.9	330.7
Total FCOC Carbon, µgrams		185.0	µgrams	0.2	mgrams					
Total BFA Carbon, µgrams		2954.3	µgrams	3.0	mgrams					

SCREENS	Total Carbon, µg	Background Carbon, µg	Effective Carbon, µg	MWWT Start	MWWT End	Delta BFA MWWT	TE	BFA AWWT Start	BFA AWWT End	Delta BFA AWWT
TMS	13.3	0.3	13.0	510.70	509.88	0.08	MAX	493.83	493.13	-0.71
F303	95.1	25.4	69.7	503.01	501.17	-1.84	TE325	**SV Inlet**	**FDV Inlet**	**BFA Inlet**
F304	61.0	12.9	48.1	510.70	509.88	-0.81	TE324	**(TE702)**	**(TE313)**	**(TE316)**
F305	0.0	0.0	0.0	508.34	508.42	0.08	TE323	343	328	325
F702	584.7	12.9	571.8	506.94	507.00	0.07	TE322			

Effective Carbon Deposition - µgrams/cm^2

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	13.9	11.1	8.5	6.8	10.5					
BFA	38.4	64.3	103.6	158.6	180.7	237.3	264.8	257.1	218.2	192.0

TMS Mass Change - grams

Component/Device	Tare, g	Mass, g	Mass Gain, g
TMS	0.08690	0.08692	0.00002
F303	7.12957	7.13001	0.00044
F304	3.05548	3.05536	-0.00012
F305	0.00000	0.00000	0.00000
F702	3.05393	3.05525	0.00132

Hysteresis Ratings:

- NONE: indicating that the pre-test and post-test hysteresis curves, for all intents and purposes, are nearly indistinguishable from one another. Minor differences may be seen between the pre-test and post-test curves but these are very small.
- Minor: There are small differences between per- and post-test curves. The spread for these curves is typically within 5% of one another. There may be some small changes in shift and skew for the valve. This degree of hysteresis would not be expected to alter the functional nature of the valve.
- Moderate: There are definite differences between pre-and post-test curves. There may be definite differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically between 5% and 15%. This degree of hysteresis might be expected to alter the functional nature of the valve.
- Severe: There are pronounce differences between pre-and post-test curves. There may be pronounced differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically in excess 15%. This degree of hysteresis would be considered out-of-spec for the valve.
- Non-Functional: There are major differences between pre-and post-test curves. There may be major differences in shift and skew as well. The hysteresis curve will exhibit flat segments (either vertically or horizontally). Shift and skew have majorly changed the performance envelope of the valve. This degree of hysteresis would cause the valve to be non-functional or unresponsive over small or large portions of the performance range of the valve.

Figure G- 1 Run 150 Data Summary

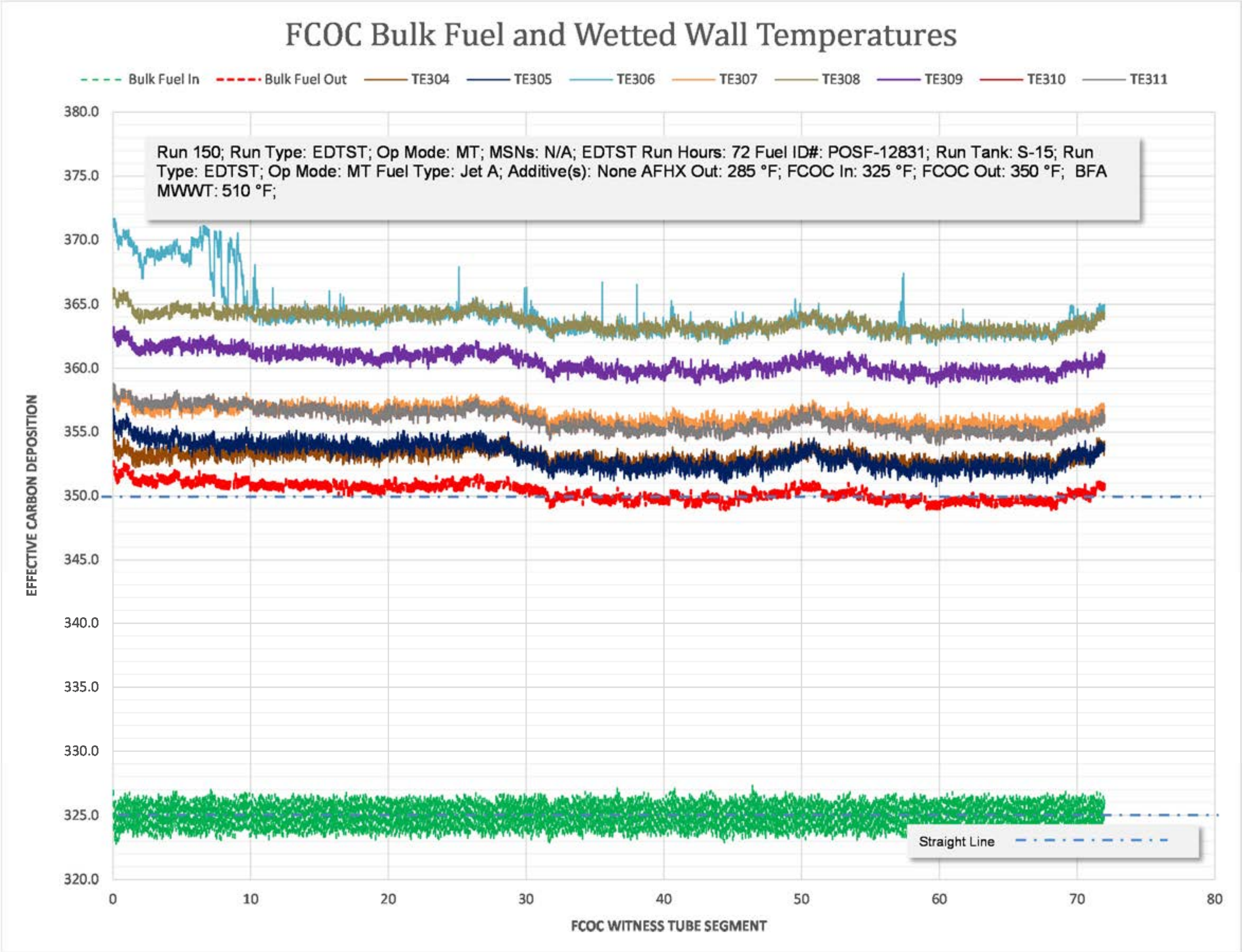


Figure G- 2 FCOC Bulk Fuel and Wetted Wall Temperatures

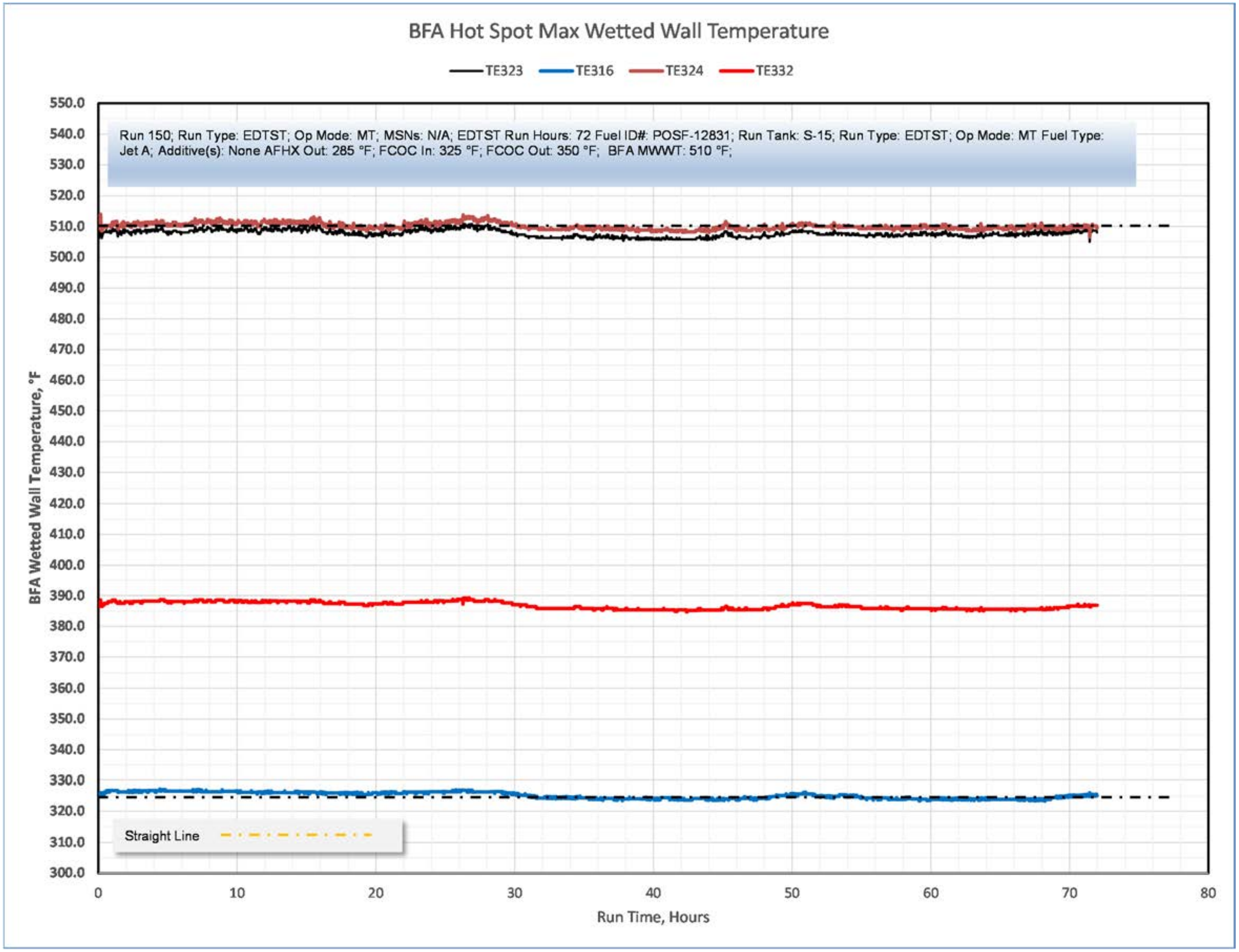


Figure G- 3 BFA Hot Spot Max Wetted Wall And Bulk Fuel Temperatures

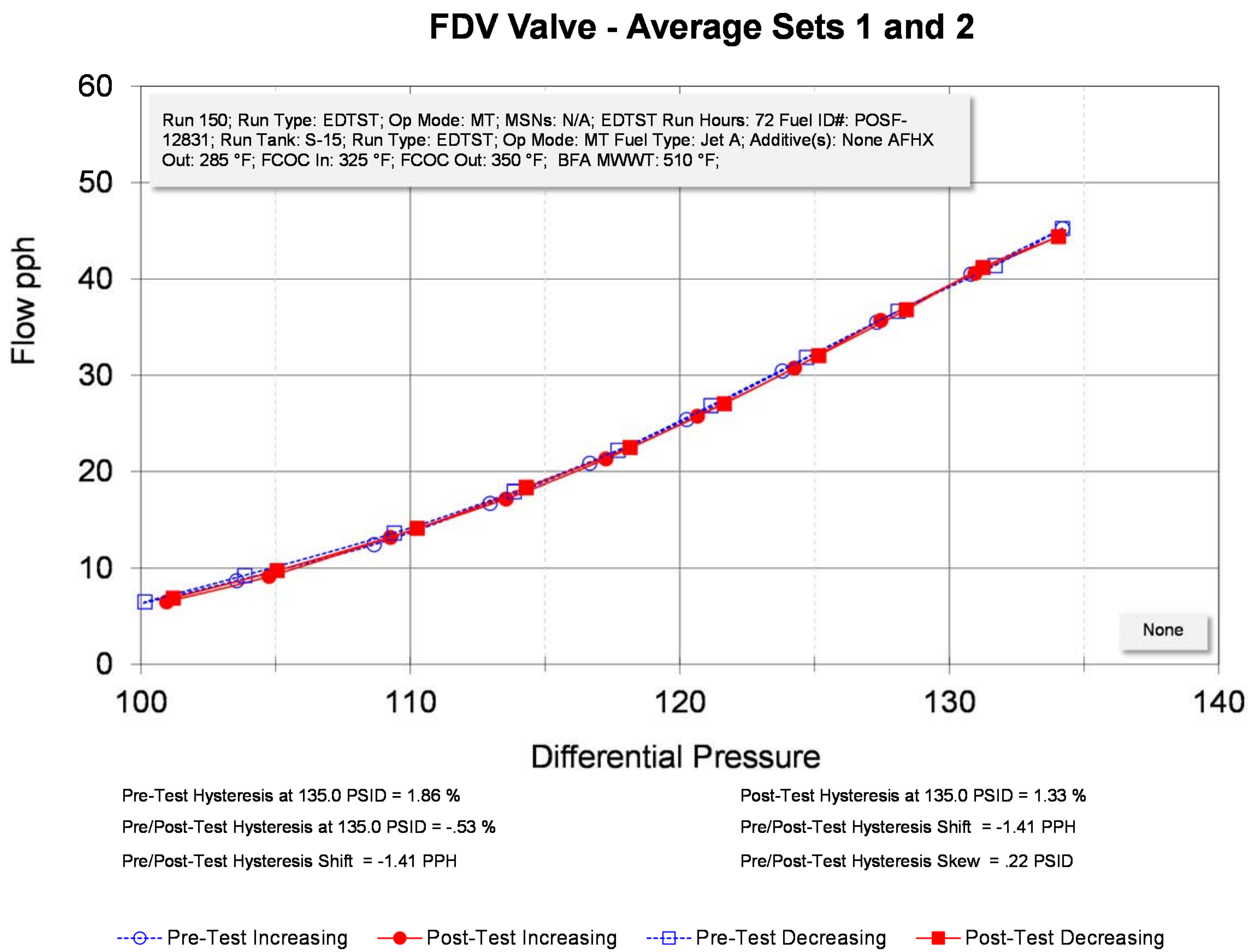
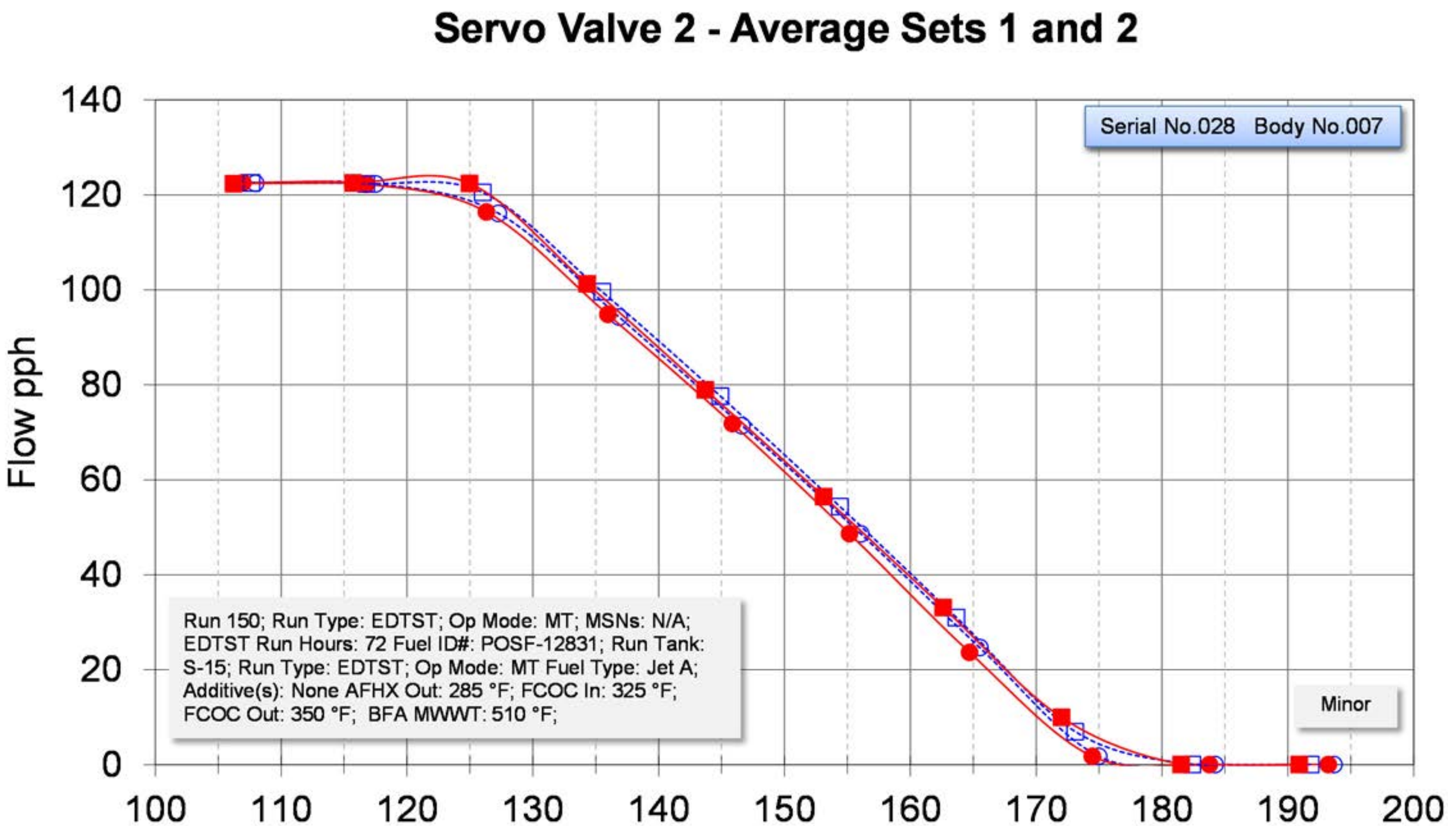


Figure G- 4 FDV Hysteresis



Pre-Test Hysteresis at 150.0 PSID = 3.3 %

Pre/Post-Test Hysteresis at 150.0 PSID = 1. %

Pre/Post-Test Hysteresis Shift = -1.5 PPH

Post-Test Hysteresis at 150.0 PSID = 4.3 %

Pre/Post-Test Hysteresis Shift = -1.5 PPH

Pre/Post-Test Hysteresis Skew = -.52 PSID

Pre-Test Increasing — Post-Test Increasing — Pre-Test Decreasing — Post-Test Decreasing

Figure G- 5 Servo Valve Hysteresis

FDV Components Comparison to Clean

Figure G- 6 FDV Components - Comparison to Clean

Servo Valve and Nozzle Screen Simulator Components – Comparison To Clean

Run 150 | Clean

Run 150 POSF-1231 MT

Figure G- 7 Servo Valve and Nozzle Screen Components - Comparison to Clean

TMS Screens Comparison to Clean

CLEAN

Figure G- 8 TMS Screen Top and Bottom - Comparison to Clean

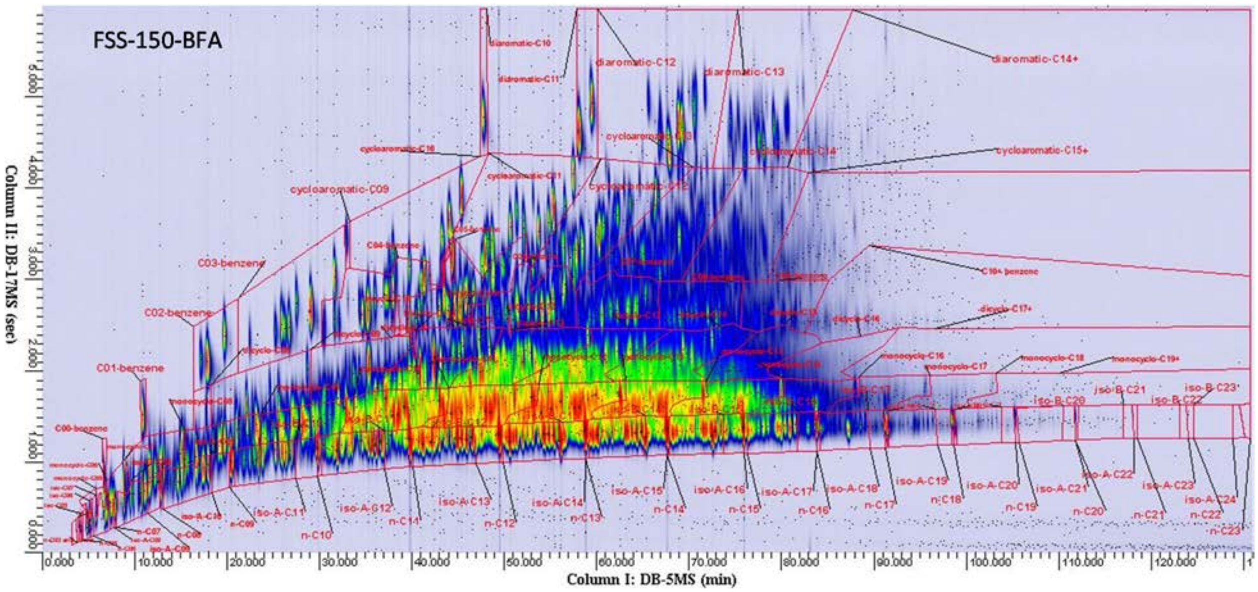


Figure G- 9 GCxGC Summary POSF-12831 BFA Outlet

Table G- 1 GCxGC Tabulated Data POSF-12831 Jet A Neat and Run 150 BFA Outlet

	POSF-12831-Jet A Neat		FSS150-BFA	
Hydrogen content (weight %)	13.9		13.9	
Average Molecular Wt (g/mole)	168		168	
	Weight %	Volume %	Weight %	Volume %
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	<0.01	<0.01
toluene (C07)	0.10	0.10	0.10	0.09
C2-benzene (C08)	0.42	0.39	0.41	0.38
C3-benzene (C09)	0.88	0.82	0.85	0.80
C4-benzene (C10)	1.47	1.37	1.45	1.35
C5-benzene (C11)	1.78	1.66	1.76	1.64
C6-benzene (C12)	1.69	1.58	1.69	1.58
C7-benzene (C13)	1.21	1.13	1.21	1.13
C8-benzene (C14)	0.99	0.92	0.98	0.92
C9-benzene (C15)	0.55	0.51	0.55	0.51
C10+-benzene (C16+)	0.24	0.23	0.24	0.23
Total Alkylbenzenes	**9.33**	8.69	**9.25**	8.62
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.11	0.08
diaromatic-C11	0.51	0.40	0.51	0.40
diaromatic-C12	0.96	0.77	0.96	0.77
diaromatic-C13	0.58	0.47	0.59	0.48
diaromatic-C14+	0.18	0.15	0.17	0.14
Total Alkylnaphthalenes	**2.33**	1.87	**2.34**	1.88
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.03	0.02	0.03	0.02
cycloaromatic-C10	0.53	0.44	0.52	0.43
cycloaromatic-C11	1.54	1.32	1.45	1.24
cycloaromatic-C12	1.67	1.45	1.74	1.51
cycloaromatic-C13	1.54	1.35	1.55	1.36
cycloaromatic-C14	0.94	0.83	0.95	0.83
cycloaromatics-C15+	0.30	0.26	0.32	0.28
Total Cycloaromatics	**6.56**	5.67	**6.57**	5.69
Total Aromatics	**18.22**	**16.24**	**18.16**	**16.18**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.24	0.29	0.23	0.28
C08-isoparaffins	0.43	0.49	0.41	0.48
C09-isoparaffins	0.58	0.65	0.55	0.62
C10-isoparaffins	1.46	1.61	1.43	1.58
C11-isoparaffins	2.76	2.99	2.71	2.93
C12-isoparaffins	4.56	4.94	4.55	4.93
C13-isoparaffins	4.75	5.04	4.78	5.06
C14-isoparaffins	4.49	4.72	4.57	4.81
C15-isoparaffins	3.64	3.81	3.69	3.85
C16-isoparaffins	1.50	1.55	1.55	1.60
C17-isoparaffins	0.46	0.47	0.48	0.50
C18-isoparaffins	0.15	0.16	0.16	0.16
C19-isoparaffins	0.08	0.08	0.08	0.08
C20-isoparaffins	0.05	0.05	0.05	0.05
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01

n-Paraffins				
n-C07 & lower	0.19	0.22	0.18	0.22
n-C08	0.38	0.43	0.37	0.42
n-C09	0.56	0.62	0.54	0.61
n-C10	1.00	1.10	0.98	1.08
n-C11	2.89	3.13	2.86	3.10
n-C12	3.11	3.32	3.09	3.31
n-C13	2.77	2.94	2.81	2.98
n-C14	2.38	2.50	2.41	2.54
n-C15	1.40	1.46	1.44	1.50
n-C16	0.34	0.36	0.36	0.37
n-C17	0.12	0.13	0.13	0.13
n-C18	0.04	0.04	0.04	0.05
n-C19	0.02	0.02	0.02	0.02
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**15.22**	16.30	**15.26**	16.33
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.49	0.51	0.47	0.49
C08-monocyclocycloparaffins	0.71	0.72	0.70	0.71
C09-monocyclocycloparaffins	1.49	1.51	1.44	1.46
C10-monocyclocycloparaffins	2.36	2.32	2.32	2.28
C11-monocyclocycloparaffins	5.59	5.63	5.49	5.53
C12-monocyclocycloparaffins	5.49	5.49	5.44	5.45
C13-monocyclocycloparaffins	5.81	5.75	5.95	5.89
C14-monocyclocycloparaffins	4.05	4.02	4.06	4.03
C15-monocyclocycloparaffins	2.58	2.55	2.66	2.63
C16-monocyclocycloparaffins	0.93	0.92	0.97	0.96
C17-monocyclocycloparaffins	0.23	0.22	0.21	0.20
C18-monocyclocycloparaffins	0.06	0.06	0.06	0.06
C19+-monocyclocycloparaffins	0.04	0.03	0.03	0.03
Total Monocycloparaffins	**29.82**	29.73	**29.82**	29.73
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.27	0.25	0.28	0.26
C10-dicycloparaffins	0.71	0.64	0.69	0.62
C11-dicycloparaffins	2.43	2.28	2.38	2.24
C12-dicycloparaffins	2.60	2.46	2.57	2.43
C13-dicycloparaffins	2.89	2.73	2.87	2.71
C14-dicycloparaffins	1.89	1.78	1.97	1.86
C15-dicycloparaffins	0.63	0.59	0.61	0.58
C16-dicycloparaffins	0.04	0.03	0.03	0.03
C17+-dicycloparaffins	0.03	0.03	0.02	0.02
Total Dicycloparaffins	**11.50**	10.81	**11.44**	10.76
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.07	0.06	0.07	0.06
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.08**	0.06	**0.07**	0.06
Total Cycloparaffins	**41.40**	40.61	**41.34**	40.55
Average Molecular Formula - C	12.1		12.1	
Average Molecular Formula - H	23.2		23.2	

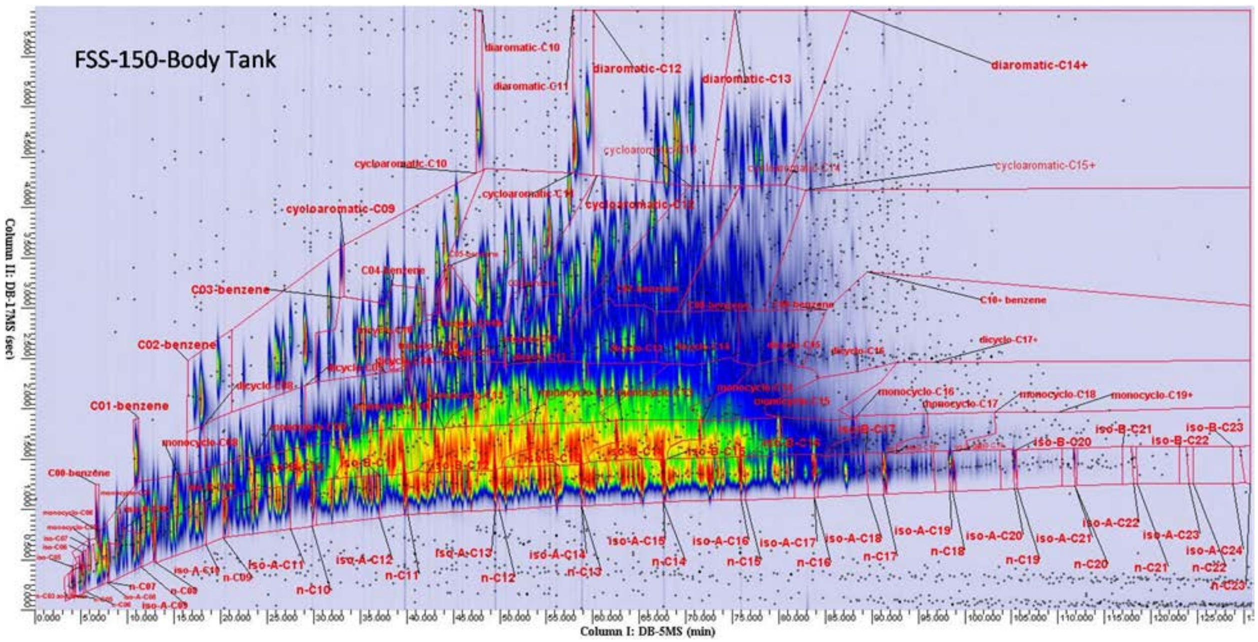


Figure G- 10 GCxGC Summary Fuel From Body Tank

Table G- 2 GCxGC Tabulated Data - Fuel From Body Tank at the End Of Run

	POSF-12831-Jet A Neat		FSS150-Body Tank	
Hydrogen content (weight %)	**13.9**		**13.9**	
Average Molecular Wt (g/mole)	**168**		**168**	
	Weight %	**Volume %**	**Weight %**	**Volume %**
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	<0.01	<0.01
toluene (C07)	0.10	0.10	0.10	0.10
C2-benzene (C08)	0.42	0.39	0.42	0.38
C3-benzene (C09)	0.88	0.82	0.87	0.81
C4-benzene (C10)	1.47	1.37	1.47	1.37
C5-benzene (C11)	1.78	1.66	1.78	1.65
C6-benzene (C12)	1.69	1.58	1.69	1.57
C7-benzene (C13)	1.21	1.13	1.21	1.13
C8-benzene (C14)	0.99	0.92	0.97	0.91
C9-benzene (C15)	0.55	0.51	0.58	0.54
C10+-benzene (C16+)	0.24	0.23	0.22	0.21
Total Alkylbenzenes	**9.33**	8.69	**9.31**	8.68
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.11	0.09
diaromatic-C11	0.51	0.40	0.50	0.40
diaromatic-C12	0.96	0.77	0.95	0.77
diaromatic-C13	0.58	0.47	0.58	0.48
diaromatic-C14+	0.18	0.15	0.17	0.14
Total Alkylnaphthalenes	**2.33**	1.87	**2.32**	1.86
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.03	0.02	0.03	0.02
cycloaromatic-C10	0.53	0.44	0.53	0.43
cycloaromatic-C11	1.54	1.32	1.46	1.25
cycloaromatic-C12	1.67	1.45	1.73	1.51
cycloaromatic-C13	1.54	1.35	1.54	1.35
cycloaromatic-C14	0.94	0.83	0.96	0.84
cycloaromatics-C15+	0.30	0.26	0.28	0.24
Total Cycloaromatics	**6.56**	5.67	**6.53**	5.65
Total Aromatics	**18.22**	**16.24**	**18.16**	**16.19**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.24	0.29	0.24	0.29
C08-isoparaffins	0.43	0.49	0.42	0.49
C09-isoparaffins	0.58	0.65	0.57	0.64
C10-isoparaffins	1.46	1.61	1.45	1.60
C11-isoparaffins	2.76	2.99	2.72	2.94
C12-isoparaffins	4.56	4.94	4.49	4.87
C13-isoparaffins	4.75	5.04	4.86	5.15
C14-isoparaffins	4.49	4.72	4.52	4.75
C15-isoparaffins	3.64	3.81	3.66	3.82
C16-isoparaffins	1.50	1.55	1.52	1.57
C17-isoparaffins	0.46	0.47	0.47	0.48
C18-isoparaffins	0.15	0.16	0.15	0.16
C19-isoparaffins	0.08	0.08	0.07	0.07
C20-isoparaffins	0.05	0.05	0.05	0.05
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01

n-Paraffins				
n-C07 & lower	0.19	0.22	0.19	0.22
n-C08	0.38	0.43	0.38	0.43
n-C09	0.56	0.62	0.55	0.62
n-C10	1.00	1.10	1.01	1.10
n-C11	2.89	3.13	2.89	3.13
n-C12	3.11	3.32	3.10	3.31
n-C13	2.77	2.94	2.79	2.96
n-C14	2.38	2.50	2.42	2.55
n-C15	1.40	1.46	1.41	1.47
n-C16	0.34	0.36	0.35	0.36
n-C17	0.12	0.13	0.13	0.14
n-C18	0.04	0.04	0.04	0.04
n-C19	0.02	0.02	0.02	0.02
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**15.22**	16.30	**15.29**	16.36
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.49	0.51	0.48	0.50
C08-monocyclocycloparaffins	0.71	0.72	0.71	0.72
C09-monocyclocycloparaffins	1.49	1.51	1.47	1.49
C10-monocyclocycloparaffins	2.36	2.32	2.35	2.30
C11-monocyclocycloparaffins	5.59	5.63	5.68	5.72
C12-monocyclocycloparaffins	5.49	5.49	5.41	5.42
C13-monocyclocycloparaffins	5.81	5.75	5.92	5.86
C14-monocyclocycloparaffins	4.05	4.02	3.99	3.96
C15-monocyclocycloparaffins	2.58	2.55	2.60	2.57
C16-monocyclocycloparaffins	0.93	0.92	0.93	0.92
C17-monocyclocycloparaffins	0.23	0.22	0.22	0.21
C18-monocyclocycloparaffins	0.06	0.06	0.05	0.05
C19+-monocyclocycloparaffins	0.04	0.03	0.03	0.03
Total Monocycloparaffins	**29.82**	29.73	**29.85**	29.76
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.27	0.25	0.28	0.26
C10-dicycloparaffins	0.71	0.64	0.70	0.63
C11-dicycloparaffins	2.43	2.28	2.30	2.17
C12-dicycloparaffins	2.60	2.46	2.58	2.44
C13-dicycloparaffins	2.89	2.73	2.87	2.71
C14-dicycloparaffins	1.89	1.78	1.97	1.86
C15-dicycloparaffins	0.63	0.59	0.64	0.60
C16-dicycloparaffins	0.04	0.03	0.04	0.04
C17+-dicycloparaffins	0.03	0.03	0.02	0.02
Total Dicycloparaffins	**11.50**	10.81	**11.43**	10.75
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.07	0.06	0.07	0.06
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.08**	0.06	**0.07**	0.06
Total Cycloparaffins	**41.40**	40.61	**41.35**	40.56
Average Molecular Formula - C	12.1		12.1	
Average Molecular Formula - H	23.2		23.2	

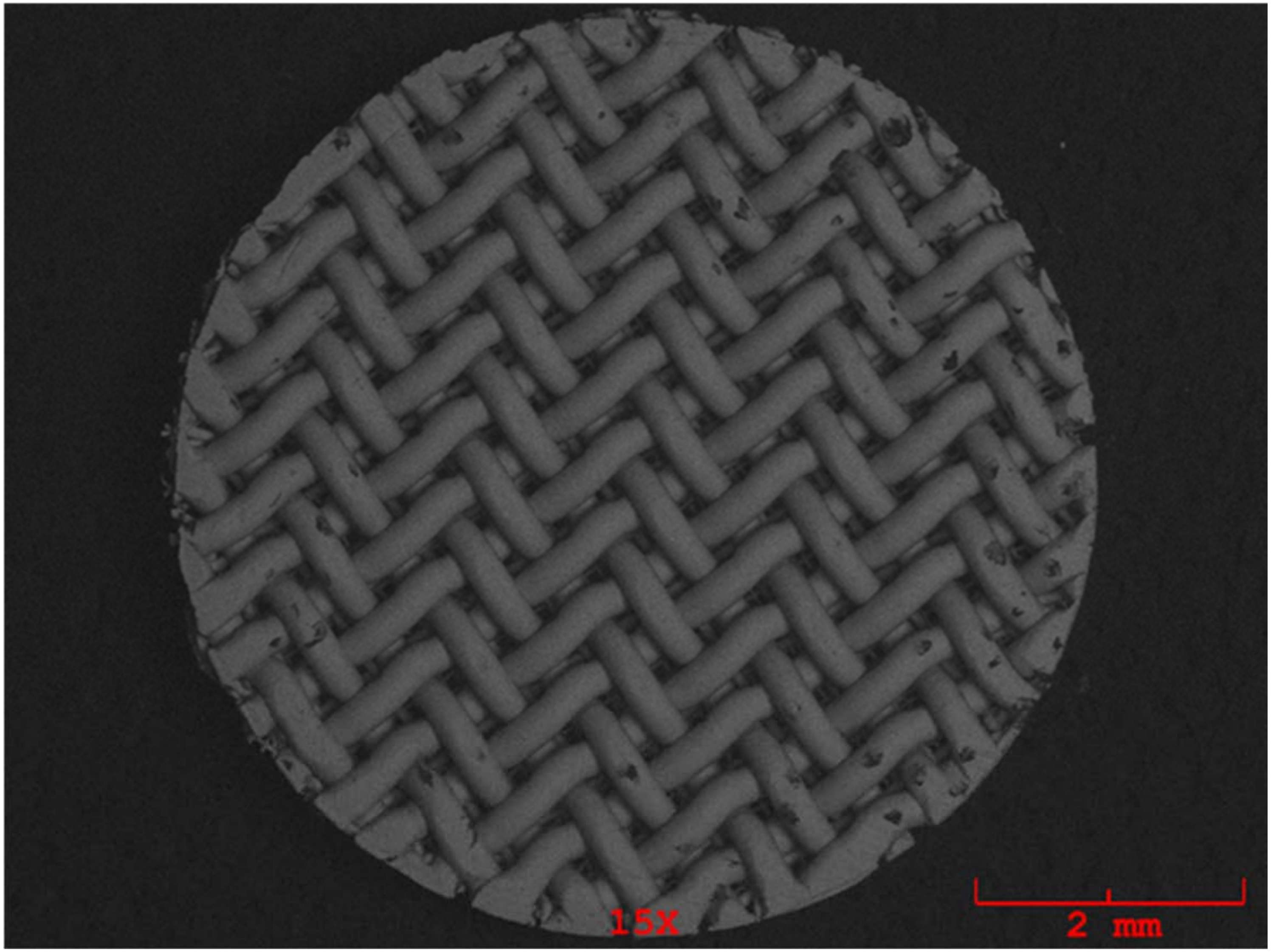
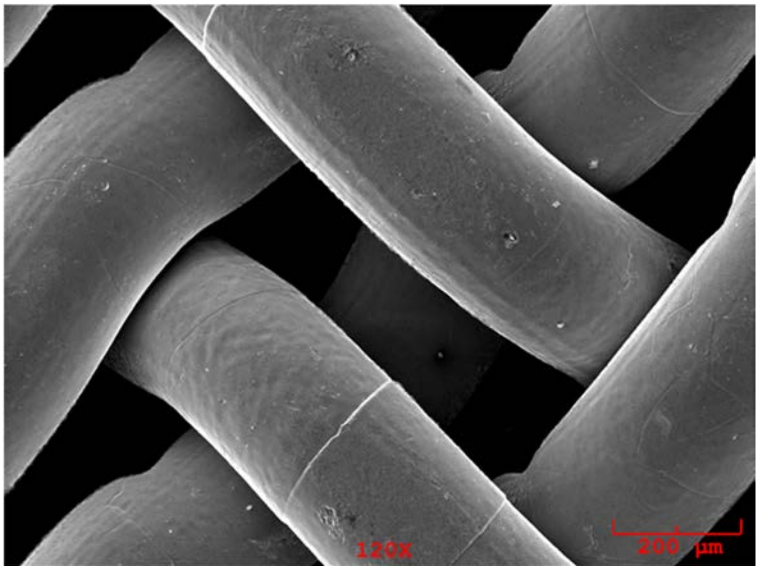


Figure G- 11 TMS Screen, Top, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	4.22	1.651	wt.%	0.260	0.314	
Al	Ka	7.17	0.702	wt.%	0.102	0.135	
Si	Ka	7.11	0.561	wt.%	0.085	0.113	
S	Ka	10.79	0.666	wt.%	0.075	0.096	
Cr	Ka	212.94	18.147	wt.%	0.263	0.130	
Fe	Ka	488.25	68.836	wt.%	0.638	0.209	
Ni	Ka	44.79	9.437	wt.%	0.330	0.262	
			100.000	wt.%			Total

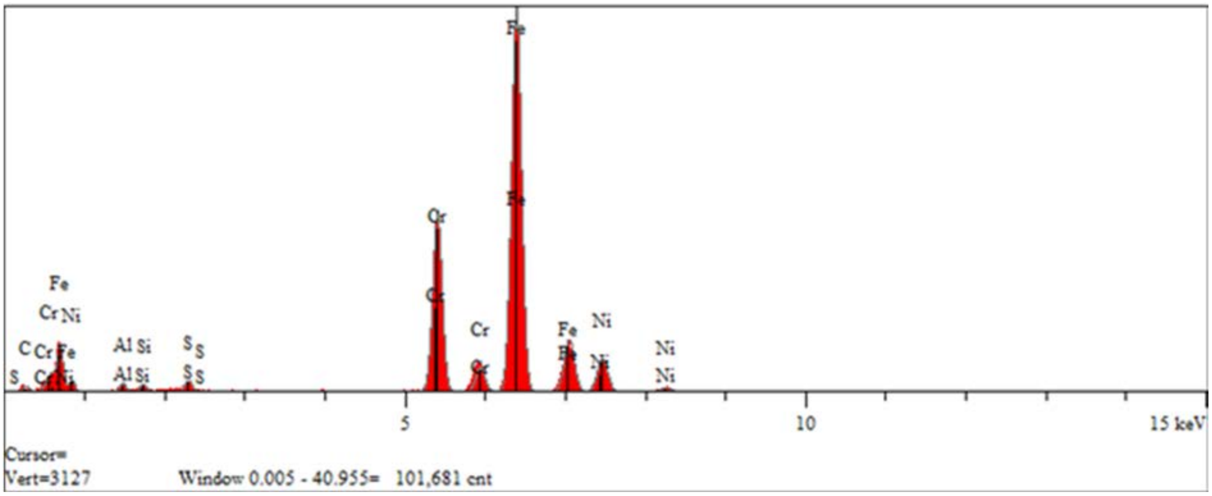


Figure G- 12 TMS Screen Top, 120X and EDX Elemental Analysis

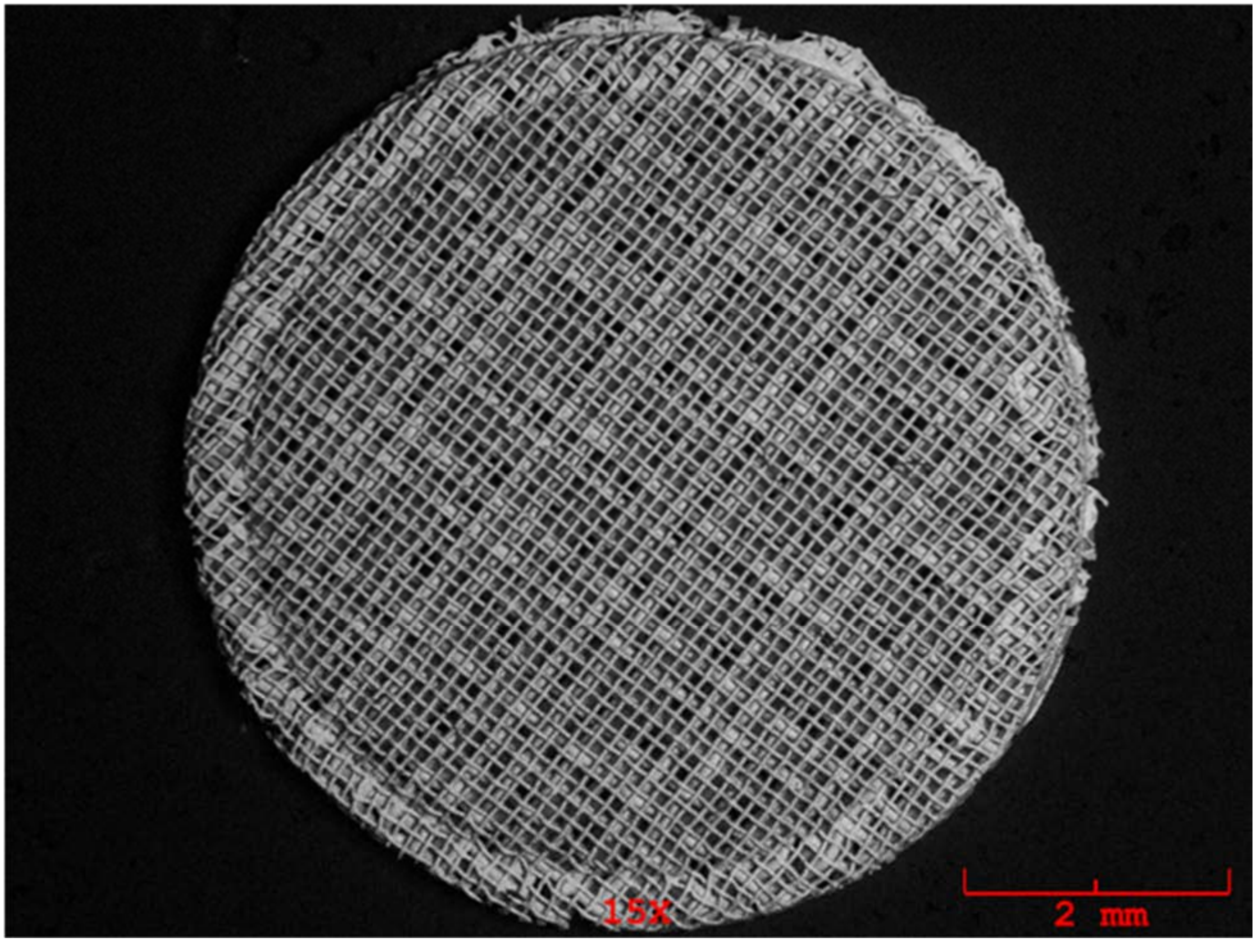
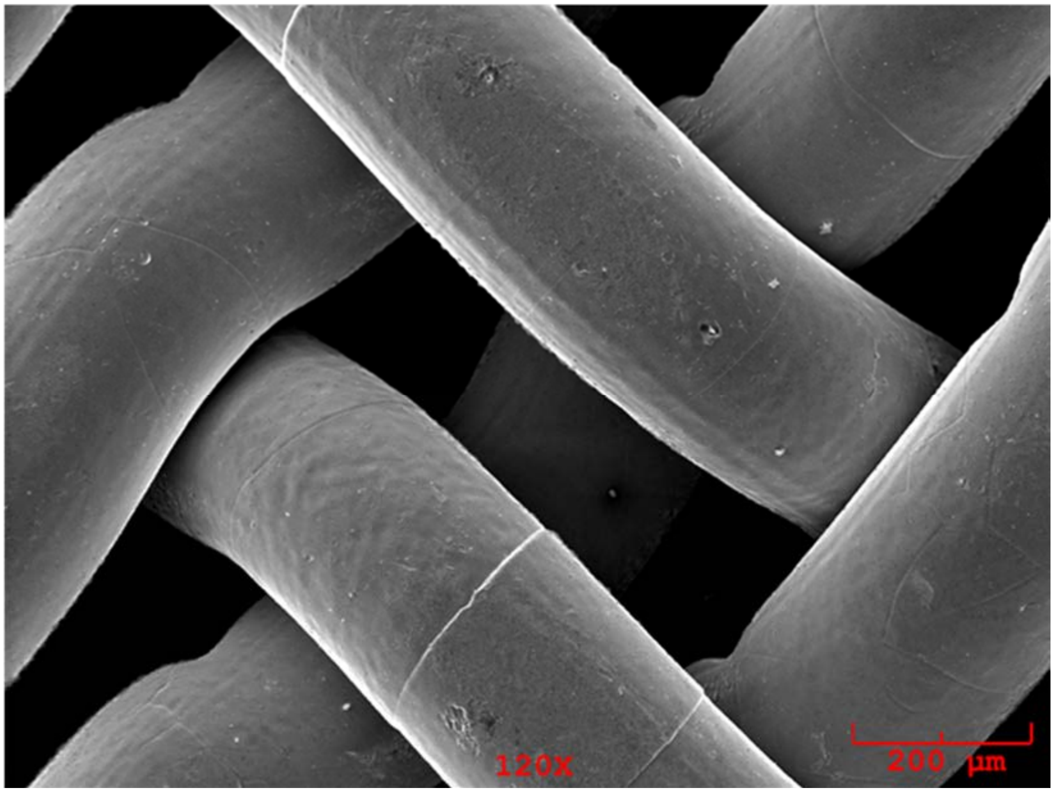


Figure G- 13 TMS Screen, Bottom, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	4.22	1.651	wt.%	0.260	0.314	
Al	Ka	7.17	0.702	wt.%	0.102	0.135	
Si	Ka	7.11	0.561	wt.%	0.085	0.113	
S	Ka	10.79	0.666	wt.%	0.075	0.096	
Cr	Ka	212.94	18.147	wt.%	0.263	0.130	
Fe	Ka	488.25	68.836	wt.%	0.638	0.209	
Ni	Ka	44.79	9.437	wt.%	0.330	0.262	
			100.000	wt.%			Total

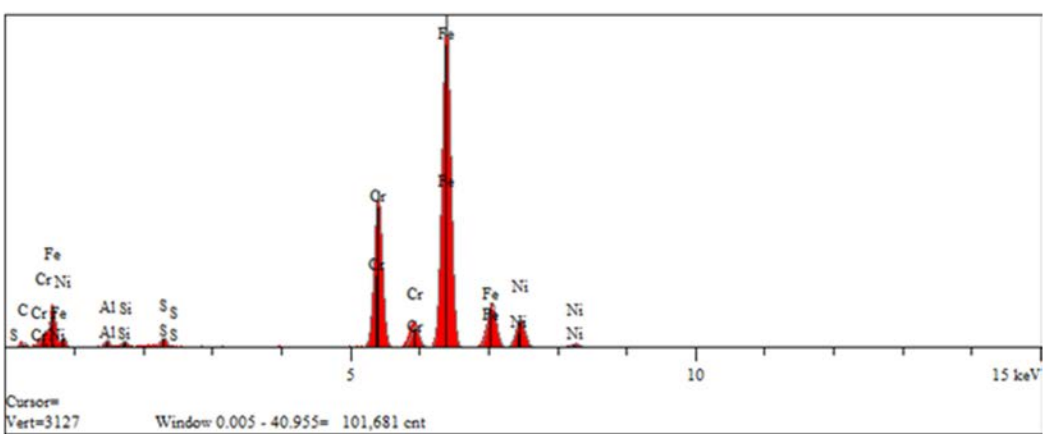


Figure G- 14 TMS Screen, Bottom, 120X and EDX Elemental Analysis

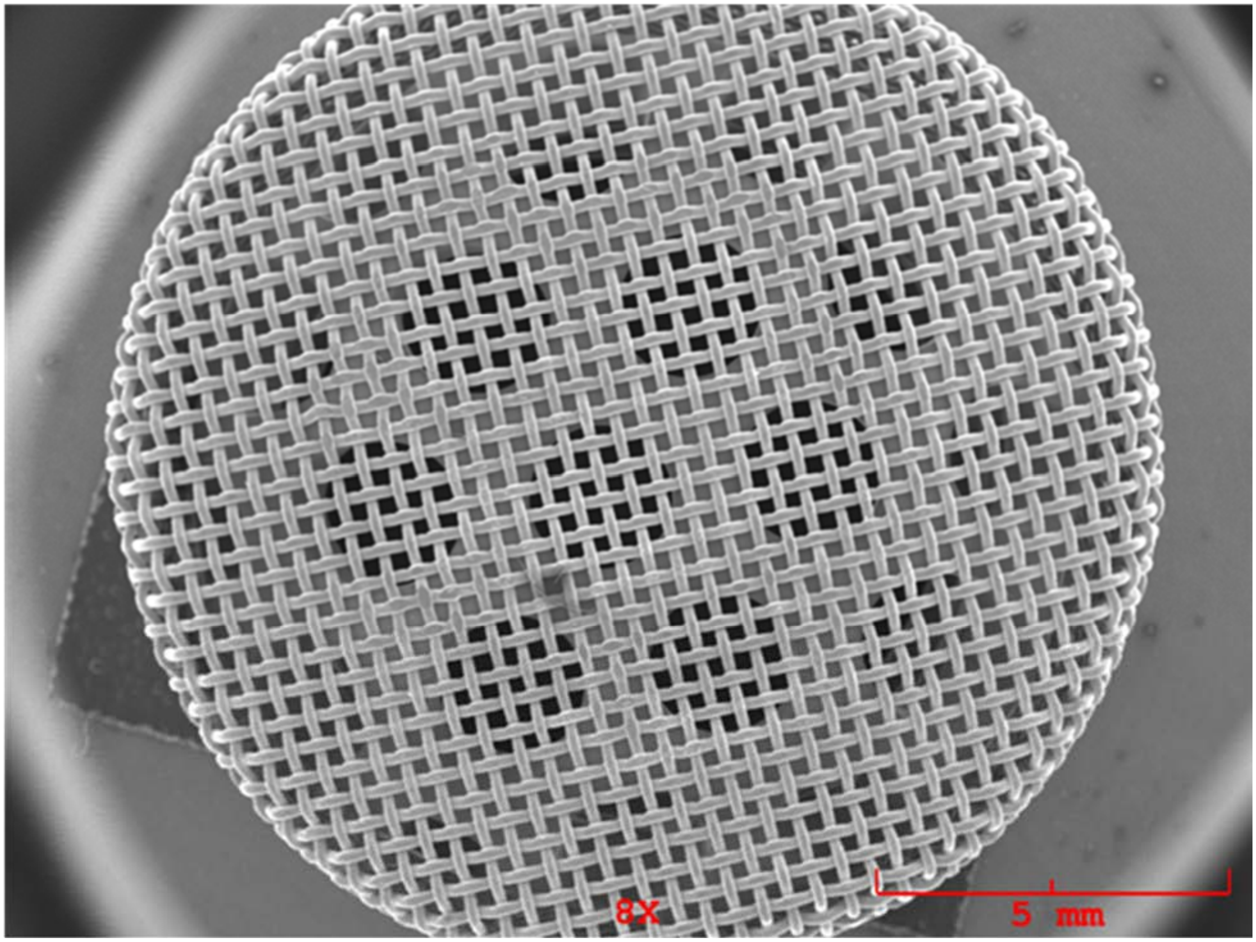
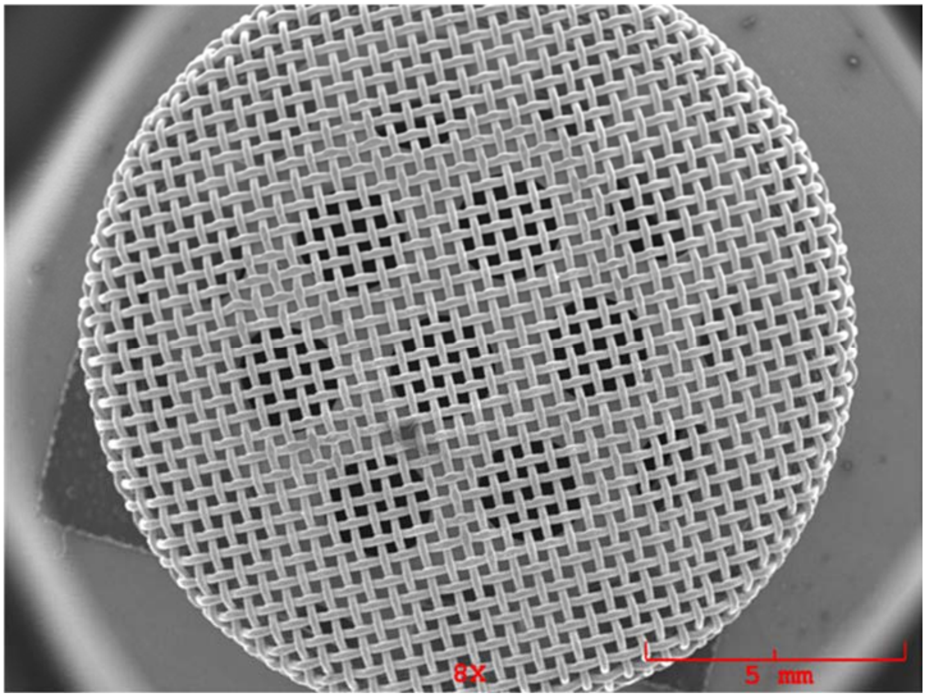


Figure G- 15 F303 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	6.80	2.828	wt.%	0.335	0.390	
Al	Ka	1.52	0.156	wt.%	0.098	0.144	
Si	Ka	7.02	0.577	wt.%	0.091	0.123	
S	Ka	20.44	1.322	wt.%	0.089	0.103	
Cr	Ka	190.59	17.040	wt.%	0.262	0.137	
Fe	Ka	461.98	68.467	wt.%	0.653	0.219	
Ni	Ka	43.34	9.609	wt.%	0.345	0.282	
			100.000	wt.%			Total

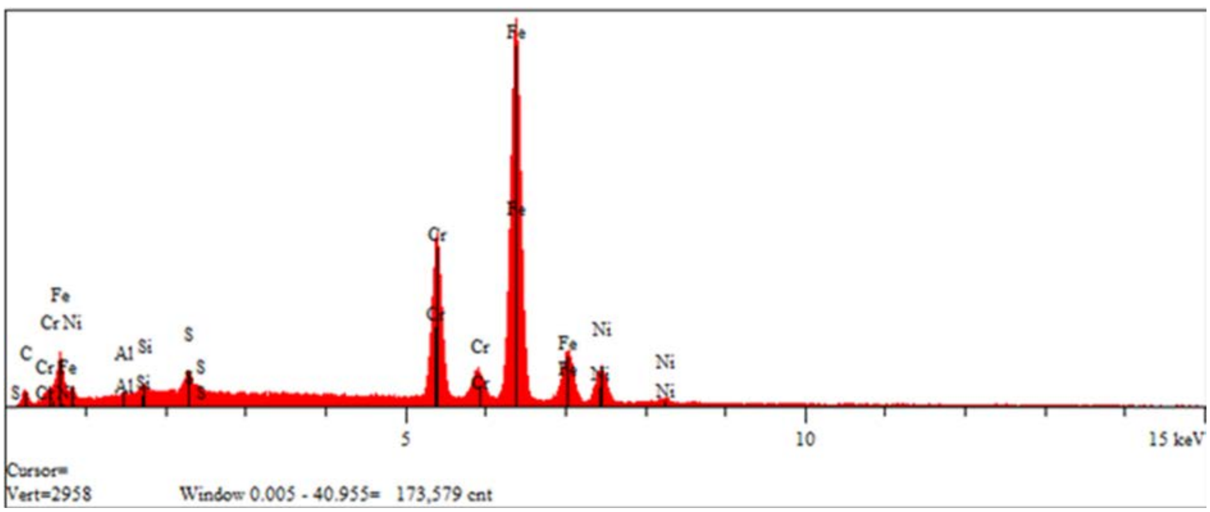


Figure G- 16 F303 Bottom 25X and EDX Elemental Analysis

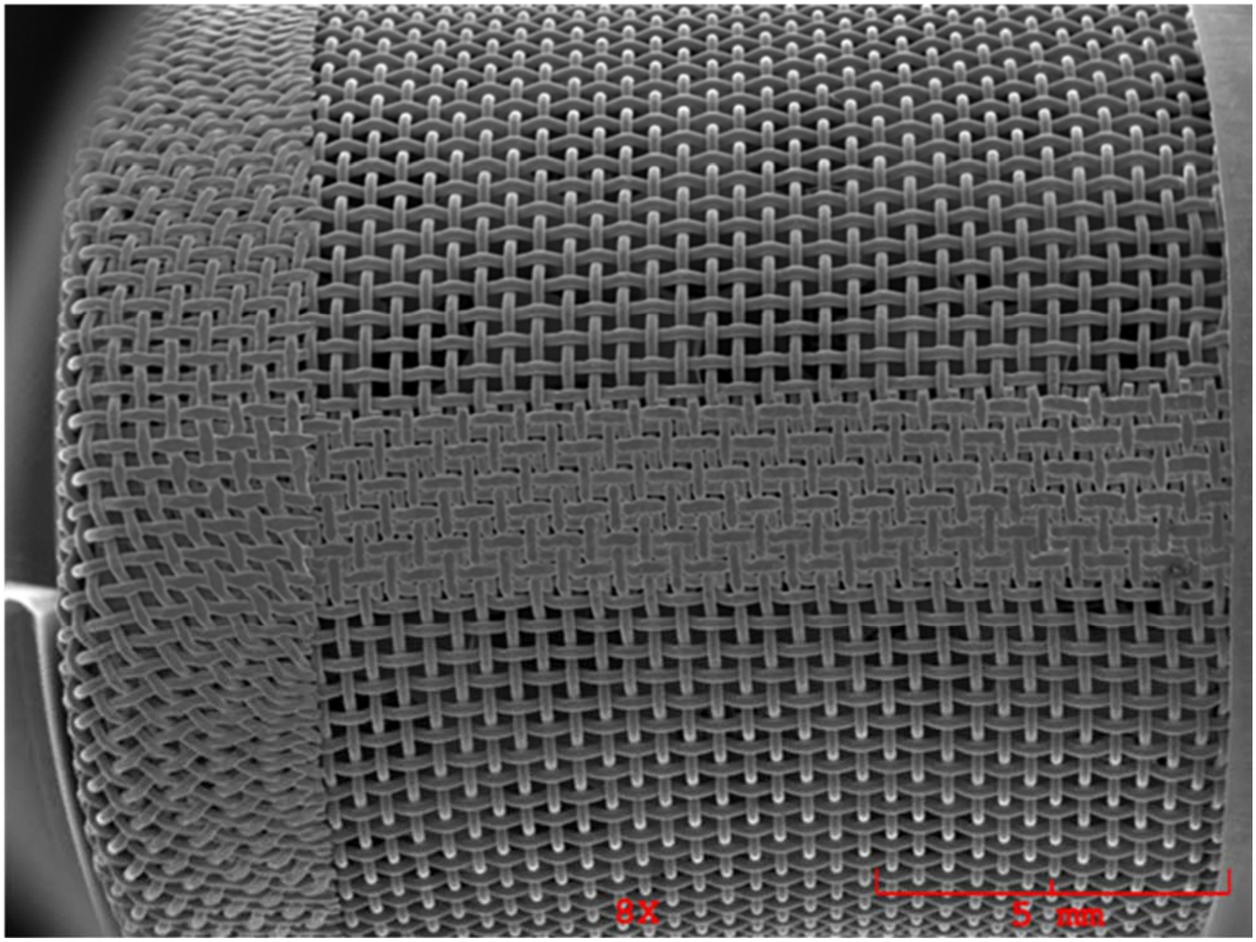
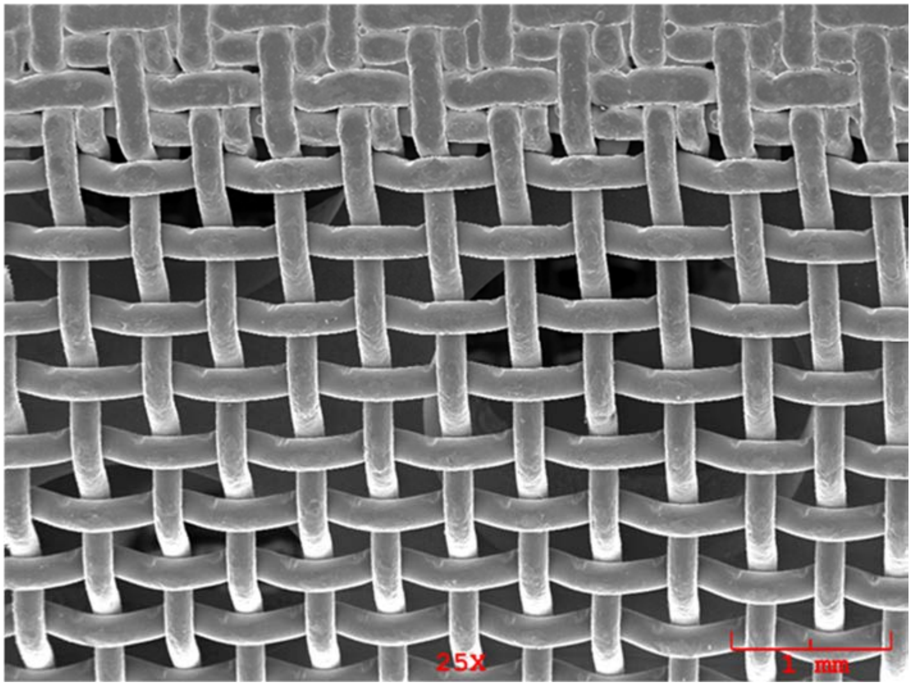


Figure G- 17 F303 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	5.05	1.907	wt.%	0.282	0.344	
Al	Ka	2.39	0.223	wt.%	0.094	0.137	
Si	Ka	7.60	0.569	wt.%	0.087	0.117	
S	Ka	20.35	1.196	wt.%	0.084	0.100	
Cr	Ka	212.51	17.180	wt.%	0.251	0.133	
Fe	Ka	516.88	69.387	wt.%	0.627	0.220	
Ni	Ka	47.46	9.537	wt.%	0.332	0.279	
			100.000	wt.%			Total

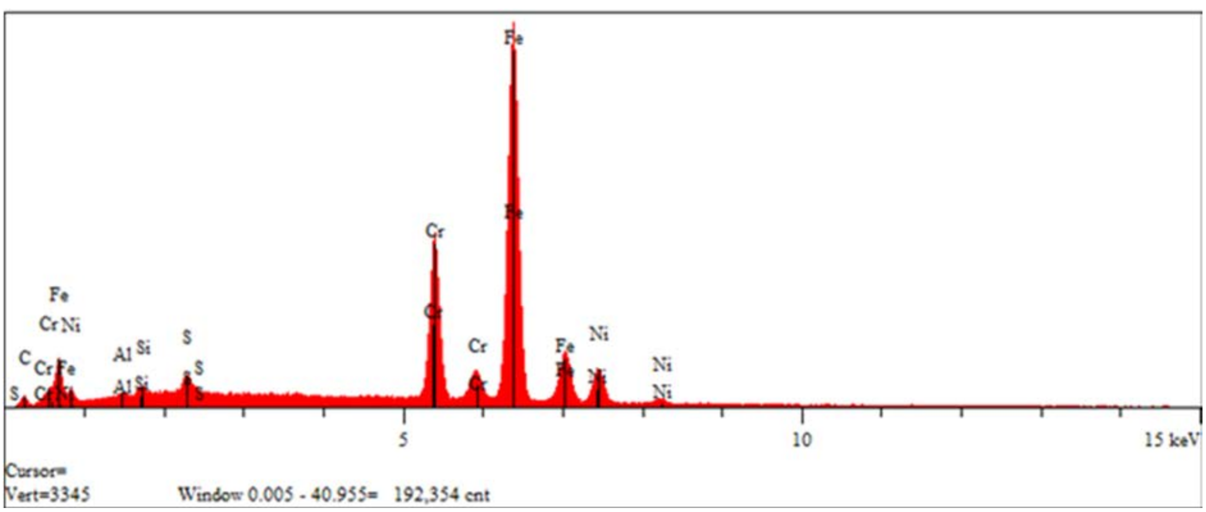


Figure G- 18 F303 Side 25X and EDX Elemental Analysis

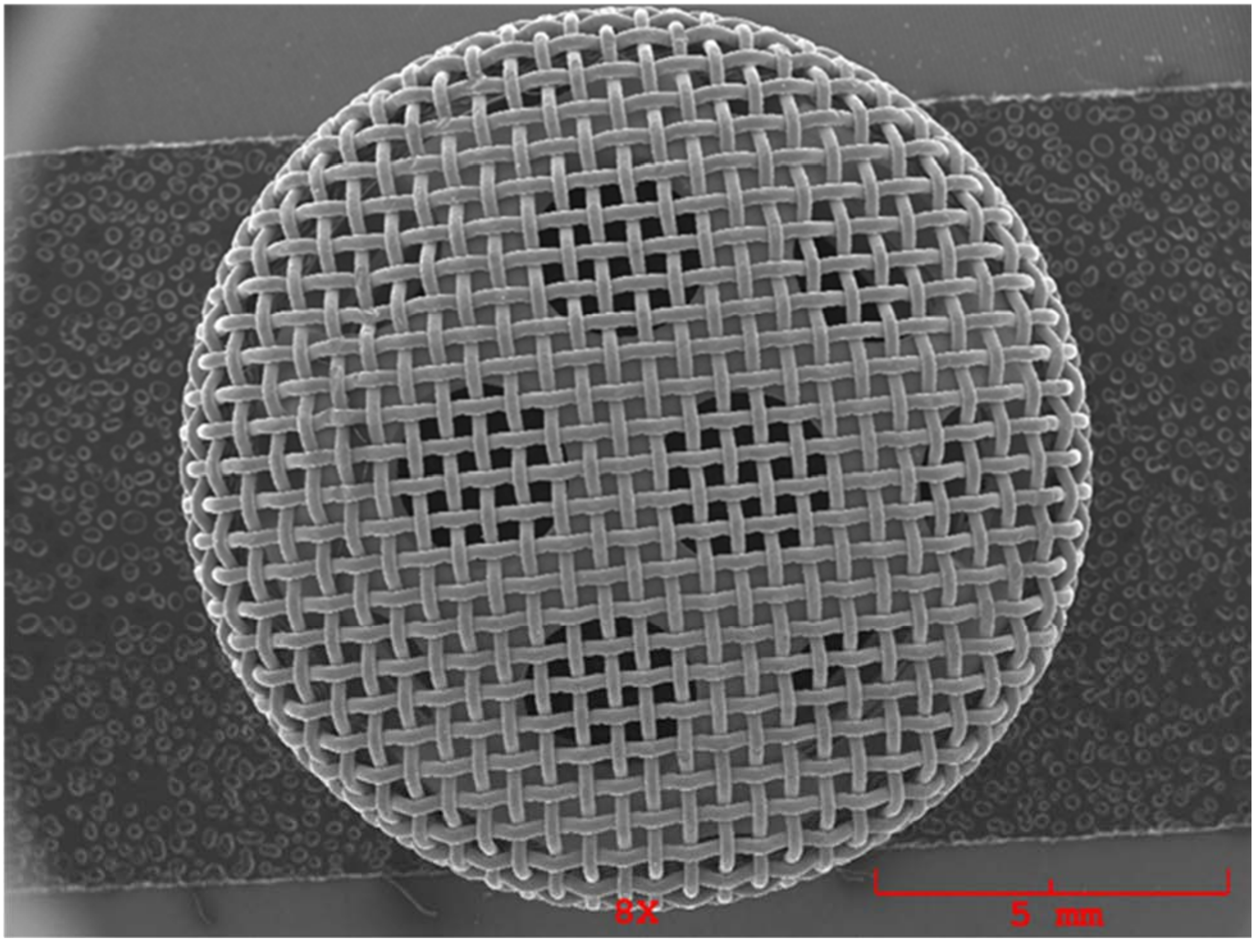
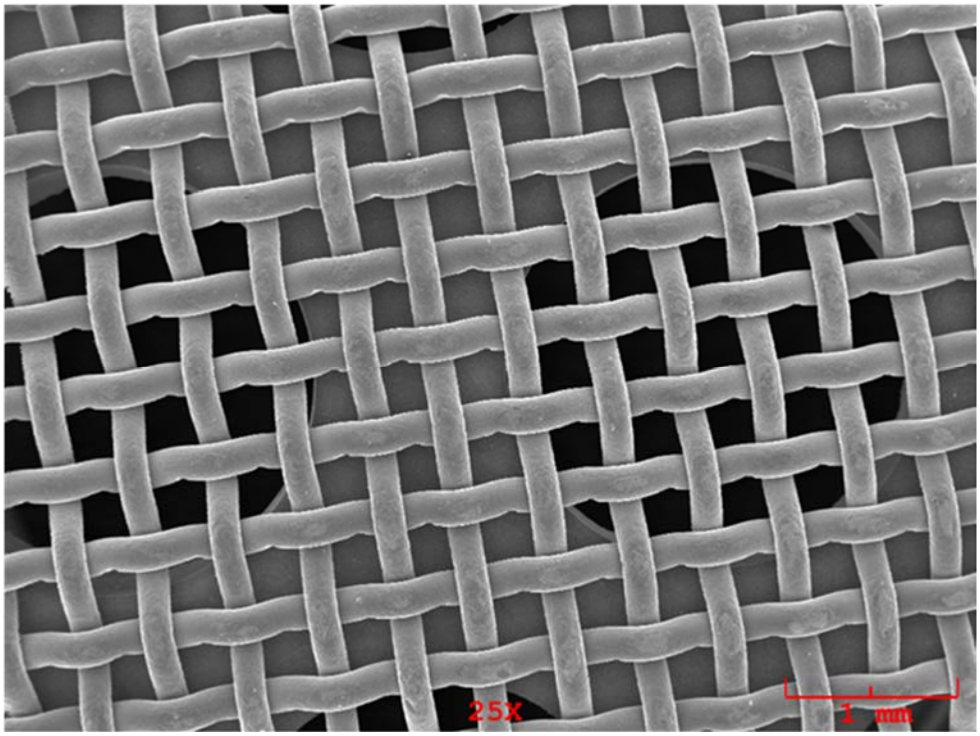


Figure G- 19 F304 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	1.70	1.729	wt.%	0.551	0.739	
Si	Ka	3.44	0.494	wt.%	0.117	0.160	
S	Ka	12.94	1.302	wt.%	0.108	0.123	
Cr	Ka	160.18	16.606	wt.%	0.276	0.132	
Fe	Ka	415.98	69.814	wt.%	0.700	0.221	
Ni	Ka	40.73	10.055	wt.%	0.356	0.255	
			100.000	wt.%			Total

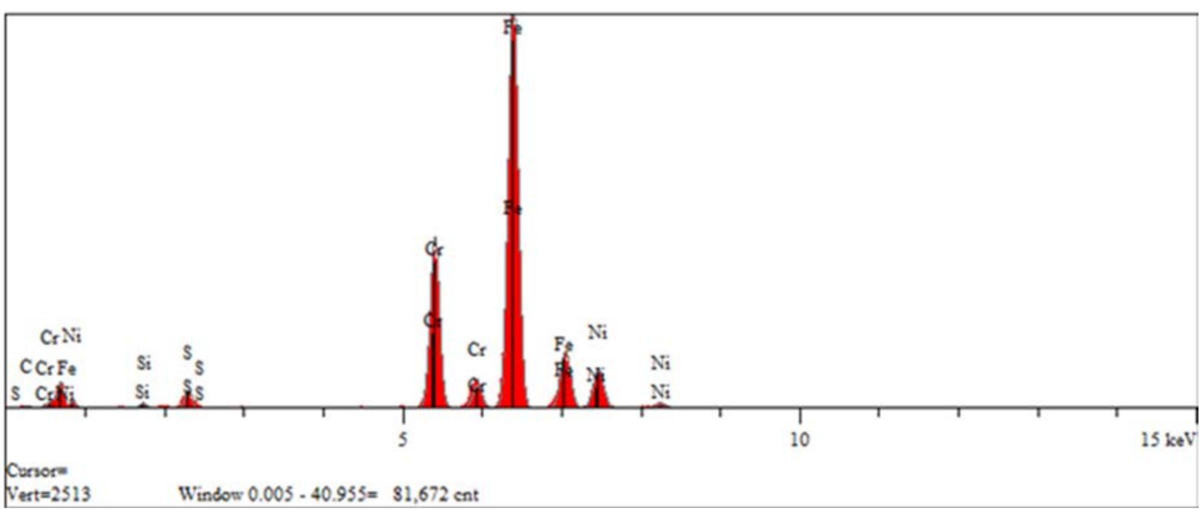


Figure G- 20 F304 Bottom, 25X and EDX Elemental Analysis

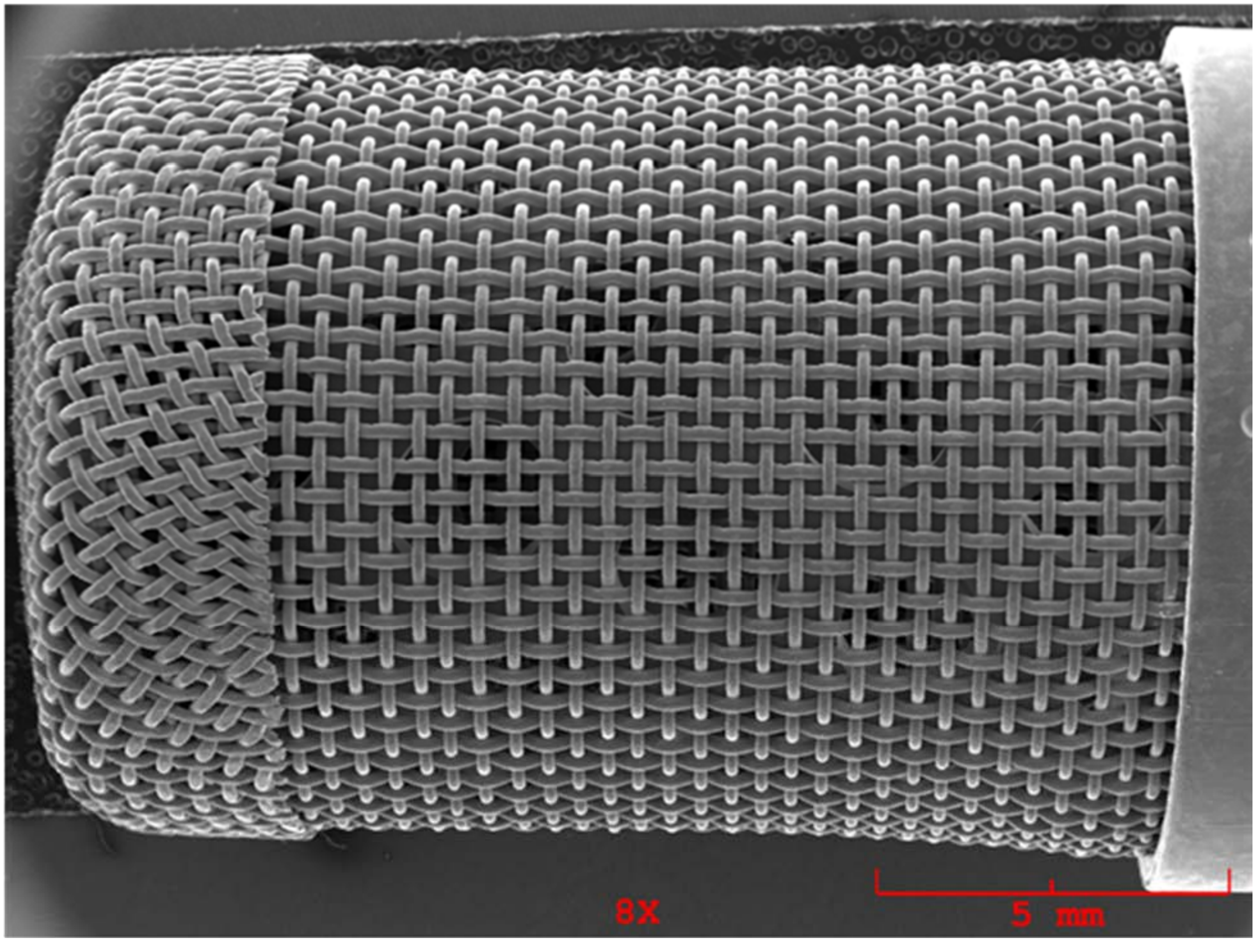
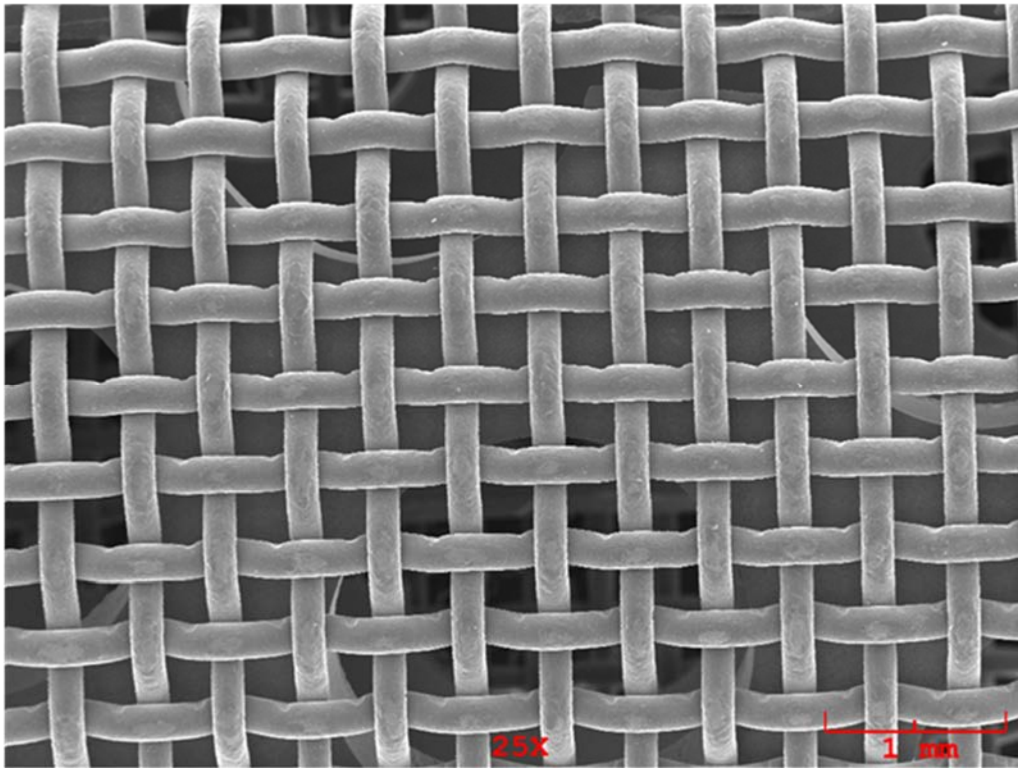


Figure G- 21 F304 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	0.94	1.130	wt.%	0.555	0.771	
Si	Ka	3.22	0.545	wt.%	0.132	0.179	
S	Ka	10.69	1.267	wt.%	0.119	0.139	
Cr	Ka	136.76	16.653	wt.%	0.300	0.146	
Fe	Ka	356.68	70.382	wt.%	0.759	0.220	
Ni	Ka	34.50	10.022	wt.%	0.388	0.283	
			100.000	wt.%			Total

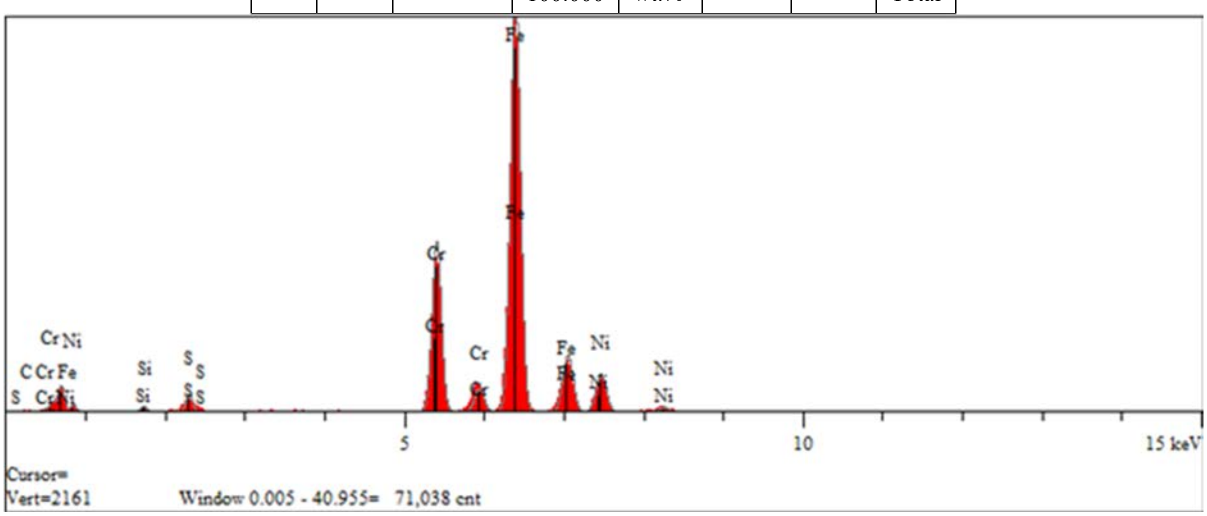


Figure G- 22 F304 Side, 25X and EDX Elemental Analysis

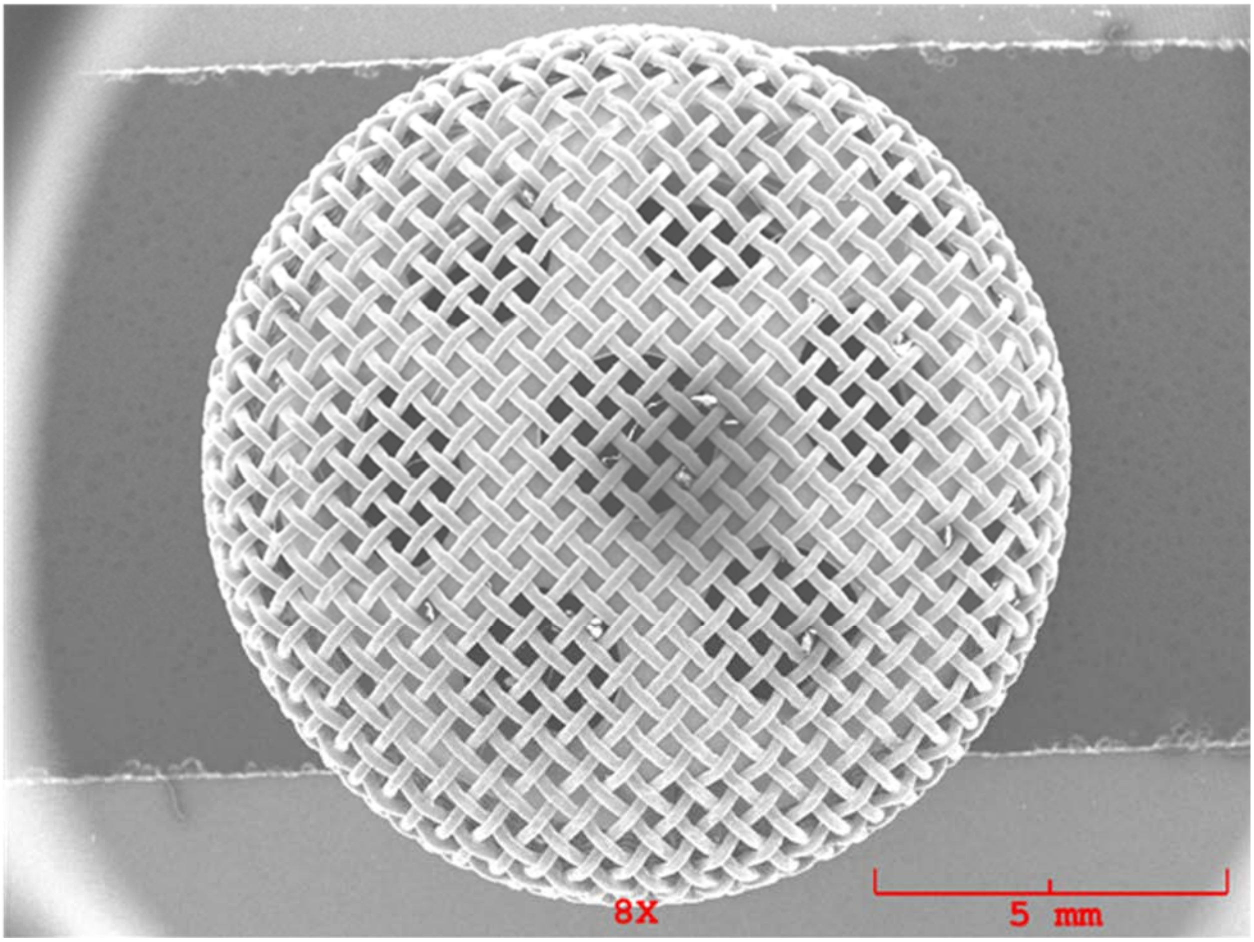
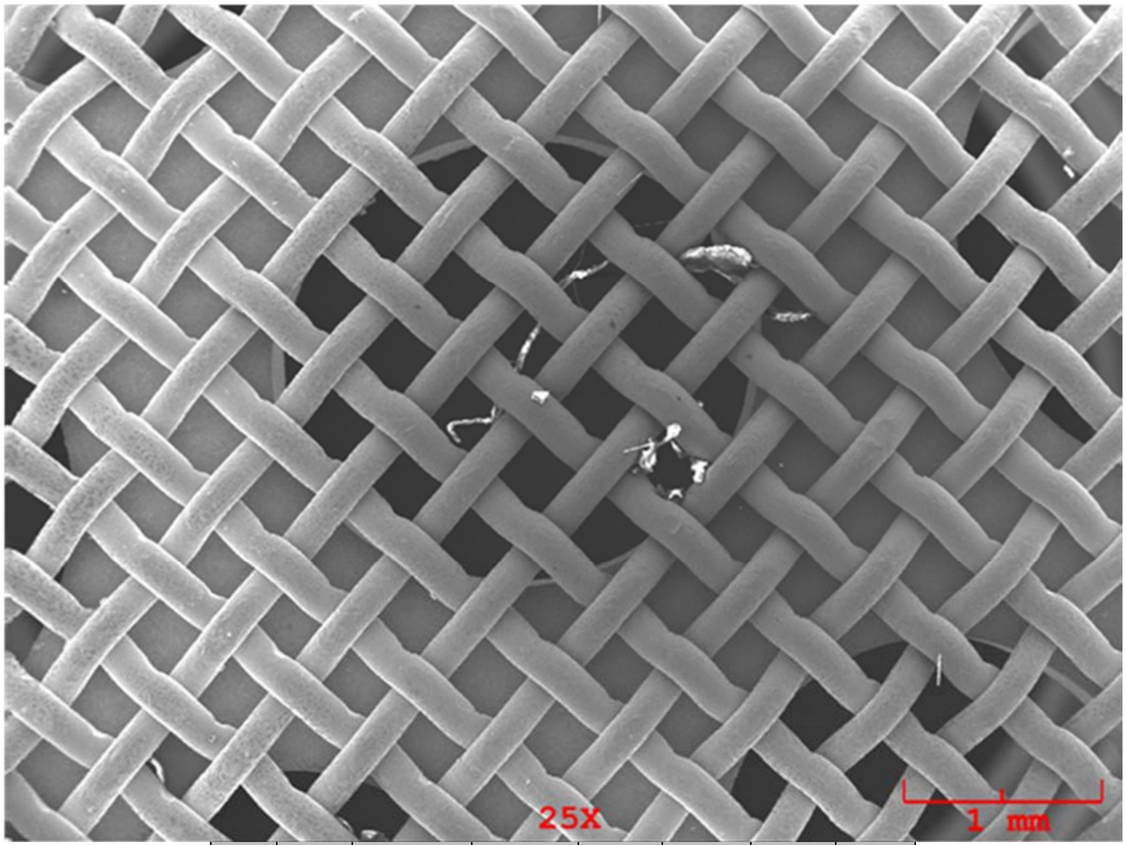


Figure G- 23 F702 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	9.89	8.282	wt.%	0.632	0.535	
Si	Ka	4.06	0.491	wt.%	0.105	0.142	
S	Ka	15.47	1.326	wt.%	0.099	0.112	
Cr	Ka	170.23	15.424	wt.%	0.250	0.125	
Fe	Ka	445.84	65.114	wt.%	0.629	0.189	
Ni	Ka	43.85	9.362	wt.%	0.322	0.235	
			100.000	wt.%			Total

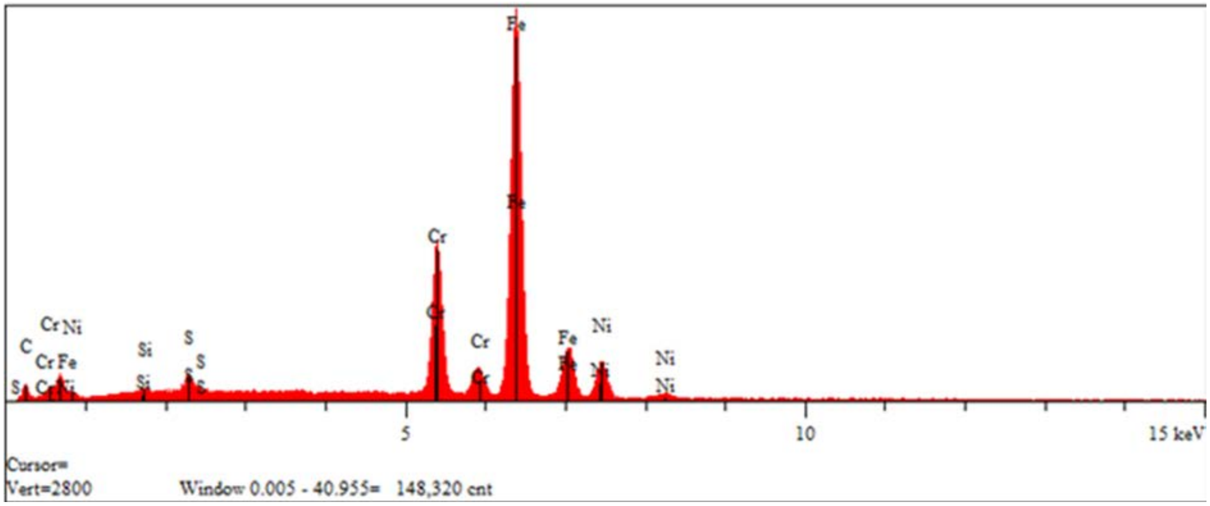


Figure G- 24 F702 Bottom, 25X and EDX Elemental Analysis

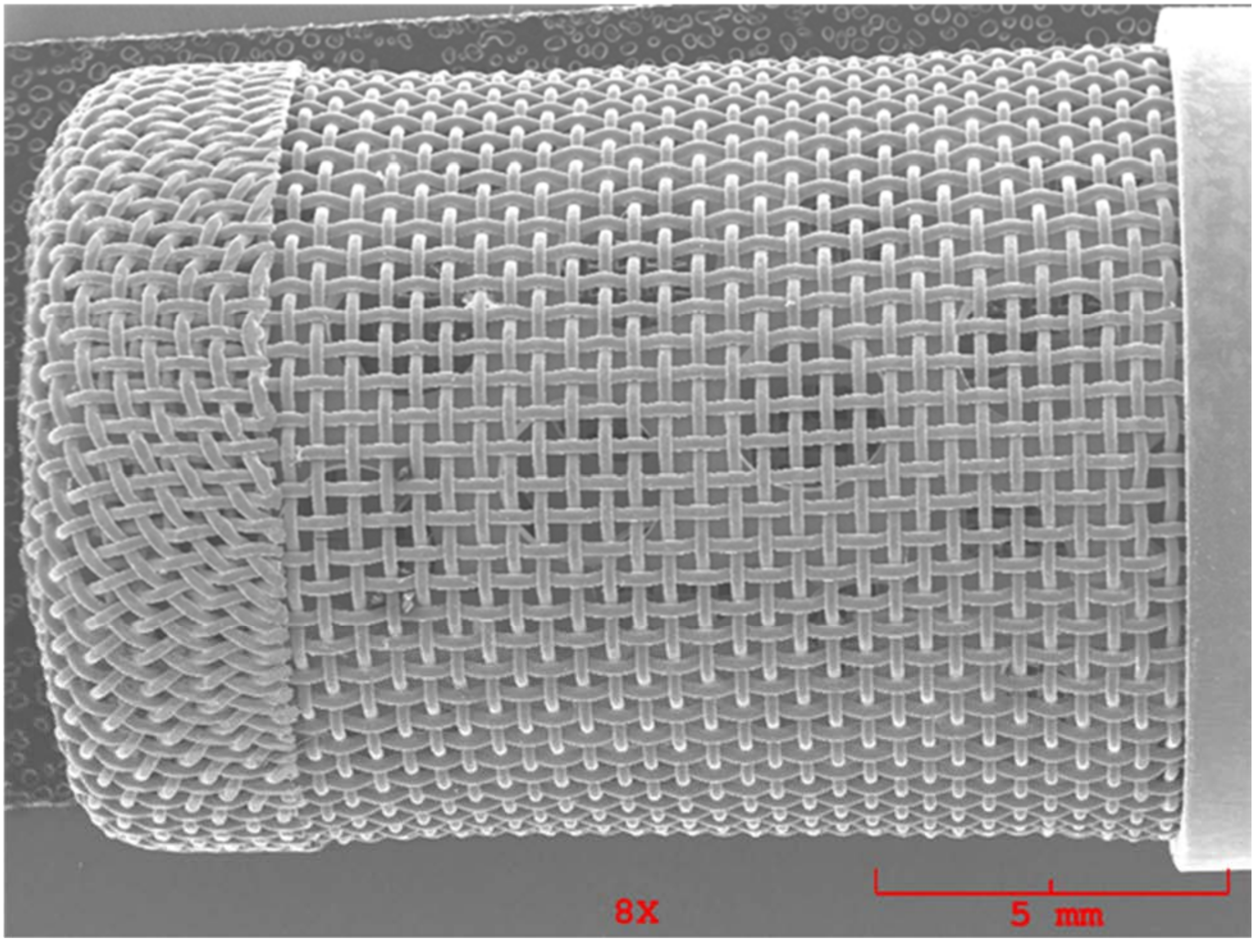
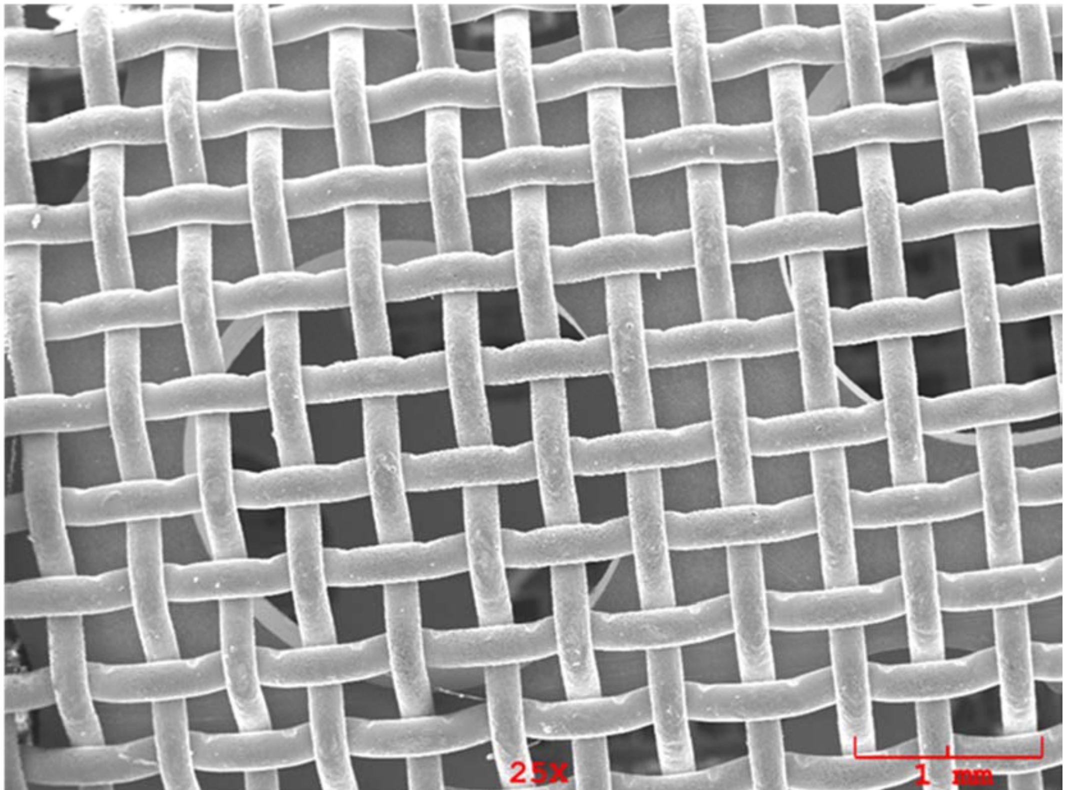


Figure G- 25 F702 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	5.27	5.480	wt.%	0.728	0.842	
Si	Ka	2.77	0.412	wt.%	0.120	0.167	
S	Ka	12.87	1.351	wt.%	0.114	0.132	
Cr	Ka	144.39	15.828	wt.%	0.278	0.138	
Fe	Ka	381.03	67.591	wt.%	0.707	0.219	
Ni	Ka	35.89	9.338	wt.%	0.359	0.272	
			100.000	wt.%			Total

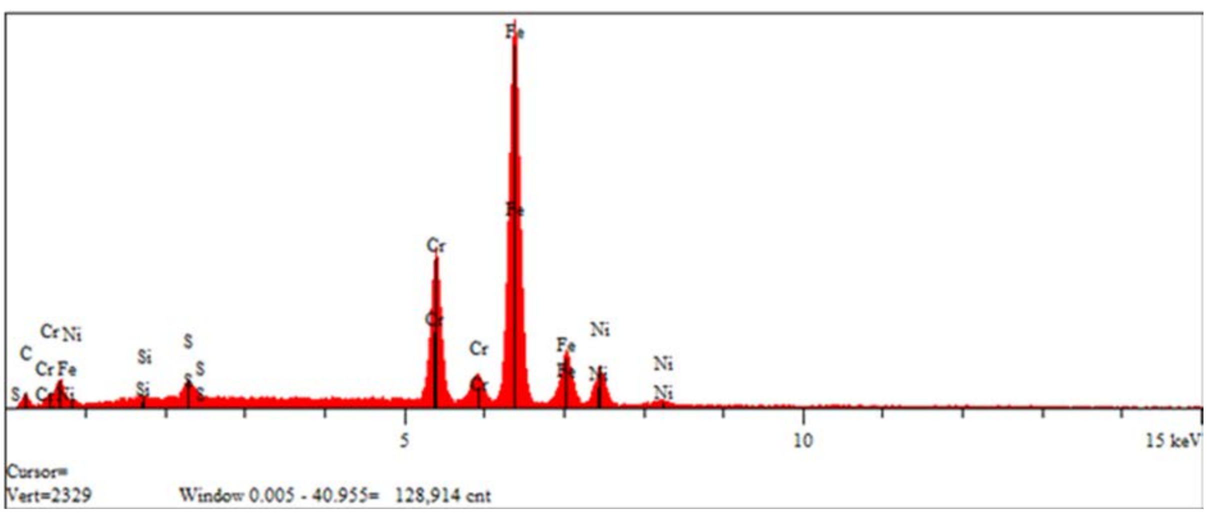


Figure G-26 F702 Side, 25X and EDX Elemental Analysis

APPENDIX H - RUN 151 DATA PACKAGE

Run Conditions: EDTST Mode, HT Conditions
Fuel ID: POSF-12831, Gulf Coast Jet A
Airframe Heat Exchanger Bulk Fuel Output: 285 °F
HP Pump HX Out/FCOC Bulk Fuel In: 350 °F
Fuel-Cooled Oil Cooler Bulk Fuel Output: 375 °F
Burner Feed Arm Max Wetted Wall Temperature: 510 °F
Run Duration: 72 Hours

DATA SUMMARY										
Run 151; Run Type: EDTST; Op Mode: HT; MSNs: N/A; EDTST Run Hours: 72 Fuel ID#: POSF-12831; Run Tank: S-15; Run Type: EDTST; Op Mode: HT Fuel Type: Jet A; Additive(s): None AFHX Out: 285 °F; FCOC In: 325 °F; FCOC Out: 375 °F; BFA MWWT: 510 °F;										
Component/Device	**Serial No.**	**Pre-Test %**	**Post-Test %**	**Spread (Pre/Post Delta), %**	**Shift, PPH**	**Skew, PSID**	**Flow Range Shift, PPH**	**Flow Midpoint Shift, PPH**	**Overall Rating**	**Hysteresis Area Change (PPH-DP)**
FDV	1249	1.3	14.1	12.8	-2.0	1.3	-3.1	-1.6	Severe	79
Servo2	011	13.7	34.7	21.0	-0.5	-0.4	0.4	0.2	Moderate	619
Effective Carbon - µgrams										
Component/Device	**Section 1**	**Section 2**	**Section 3**	**Section 4**	**Section 5**	**Section 6**	**Section 7**	**Section 8**	**Section 9**	**Section 10**
FCOC Witness Tube	55.0	50.3	48.1	48.9	58.3					
BFA	159.7	260.4	330.4	488.4	566.4	644.3	707.0	709.5	654.9	556.4
Total FCOC Carbon, µgrams		260.6	µgrams	0.3	mgrams					
Total BFA Carbon, µgrams		5077.5	µgrams	5.1	mgrams					
SCREENS	Total Carbon, µg	Background Carbon, µg	Effective Carbon, µg	MWWT Start	MWWT End	Delta BFA MWWT	TE	BFA AWWT Start	BFA AWWT End	Delta BFA AWWT
TMS	30.9	0.3	30.6	510.25	506.43	-0.73	MAX	494.84	494.77	-0.07
F303	132.5	25.4	107.1	504.04	497.95	-6.09	TE325	**SV Inlet**	**FDV Inlet**	**BFA Inlet**
F304	90.8	12.9	77.9	509.56	503.78	-5.78	TE324	**(TE702)**	**(TE313)**	**(TE316)**
F305	0.0	0.0	0.0	510.25	506.43	-3.83	TE323	368	351	347
F702	1630.3	12.9	1617.4	505.22	504.49	-0.73	TE322			
Effective Carbon Deposition - µgrams/cm^2										
Component/Device	**Section 1**	**Section 2**	**Section 3**	**Section 4**	**Section 5**	**Section 6**	**Section 7**	**Section 8**	**Section 9**	**Section 10**
FCOC Witness Tube	15.1	13.8	13.2	13.4	16.0					
BFA	92.7	151.2	191.8	283.5	328.8	374.0	410.4	411.8	380.2	323.0
TMS Mass Change - grams										
Component/Device	**Tare, g**	**Mass, g**	**Mass Gain, g**							
TMS	0.08669	0.08679	0.00010							
F303	7.18201	7.18247	0.00046							
F304	3.04487	3.04488	0.00001							
F305	0.00000	0.00000	0.00000							
F702	3.04100	3.04428	0.00328							

Hysteresis Ratings:
• NONE: indicating that the pre-test and post-test hysteresis curves, for all intents and purposes, are nearly indistinguishable from one another. Minor differences may be seen between the pre-test and post-test curves but these are very small.
• Minor: There are small differences between per- and post-test curves. The spread for these curves is typically within 5% of one another. There may be some small changes in shift and skew for the valve. This degree of hysteresis would not be expected to alter the functional nature of the valve.
• Moderate: There are definite differences between pre-and post-test curves. There may be definite differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically between 5% and 15%. This degree of hysteresis might be expected to alter the functional nature of the valve.
• Severe: There are pronounce differences between pre-and post-test curves. There may be pronounced differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically in excess 15%. This degree of hysteresis would be considered out-of-spec for the valve.
• Non-Functional: There are major differences between pre-and post-test curves. There may be major differences in shift and skew as well. The hysteresis curve will exhibit flat segments (either vertically or horizontally). Shift and skew have majorly changed the performance envelope of the valve. This degree of hysteresis would cause the valve to be non-functional or unresponsive over small or large portions of the performance range of the valve.

Figure H- 1 Run 151 Data Summary

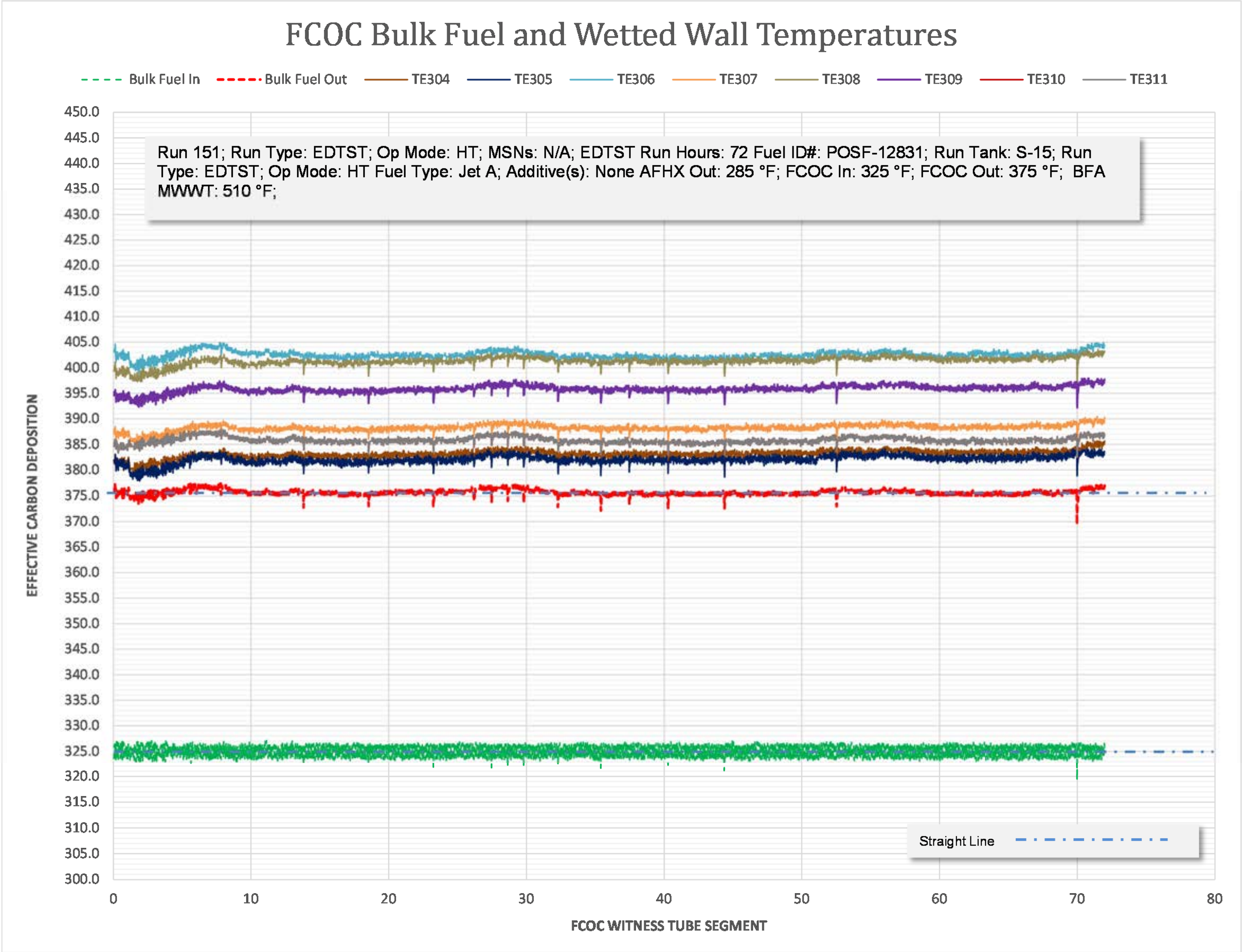


Figure H- 2 FCOC Bulk Fuel and Wetted Wall Temperatures

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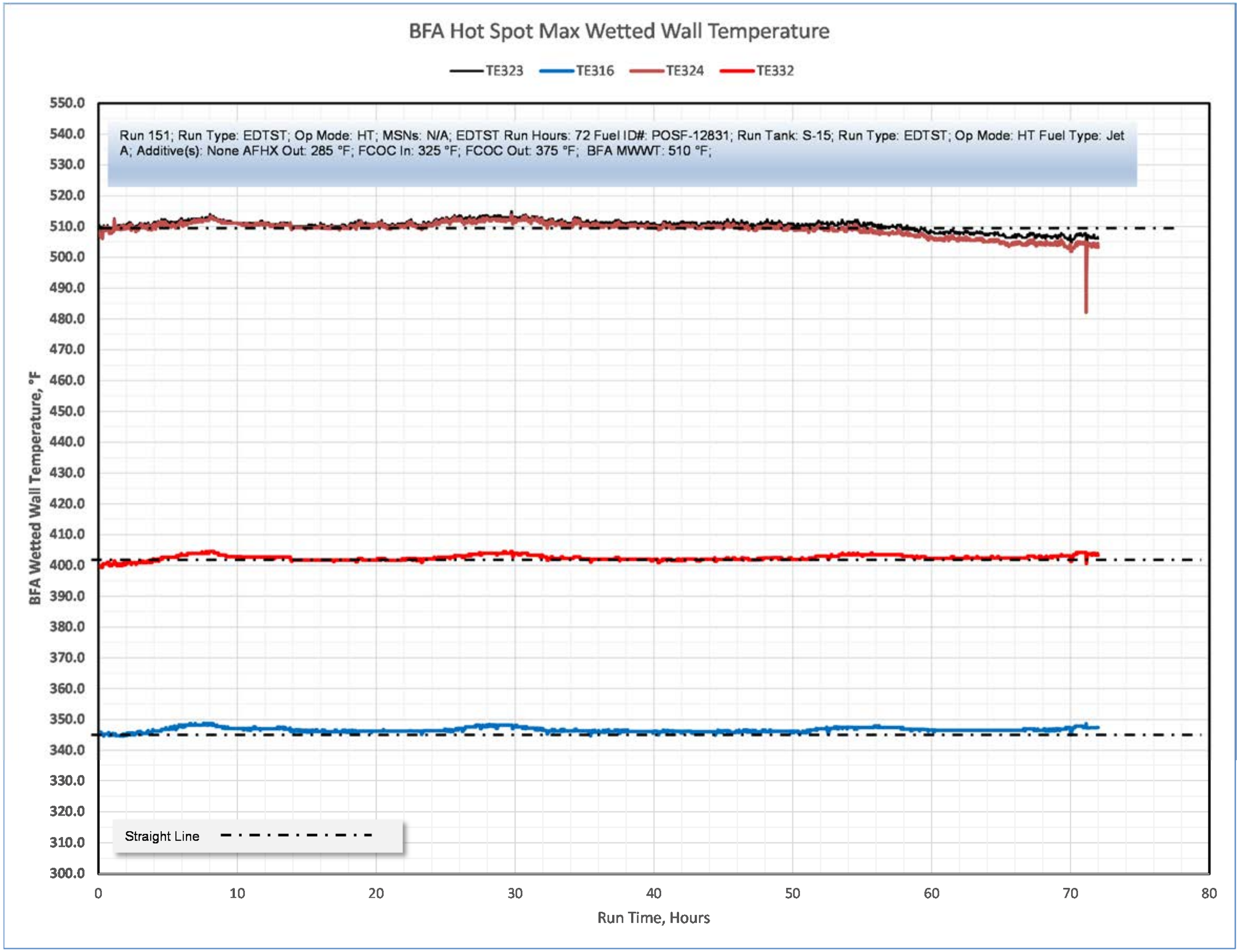


Figure H- 3 BFA Hot Spot Max Wetted Wall And Bulk Fuel Temperatures

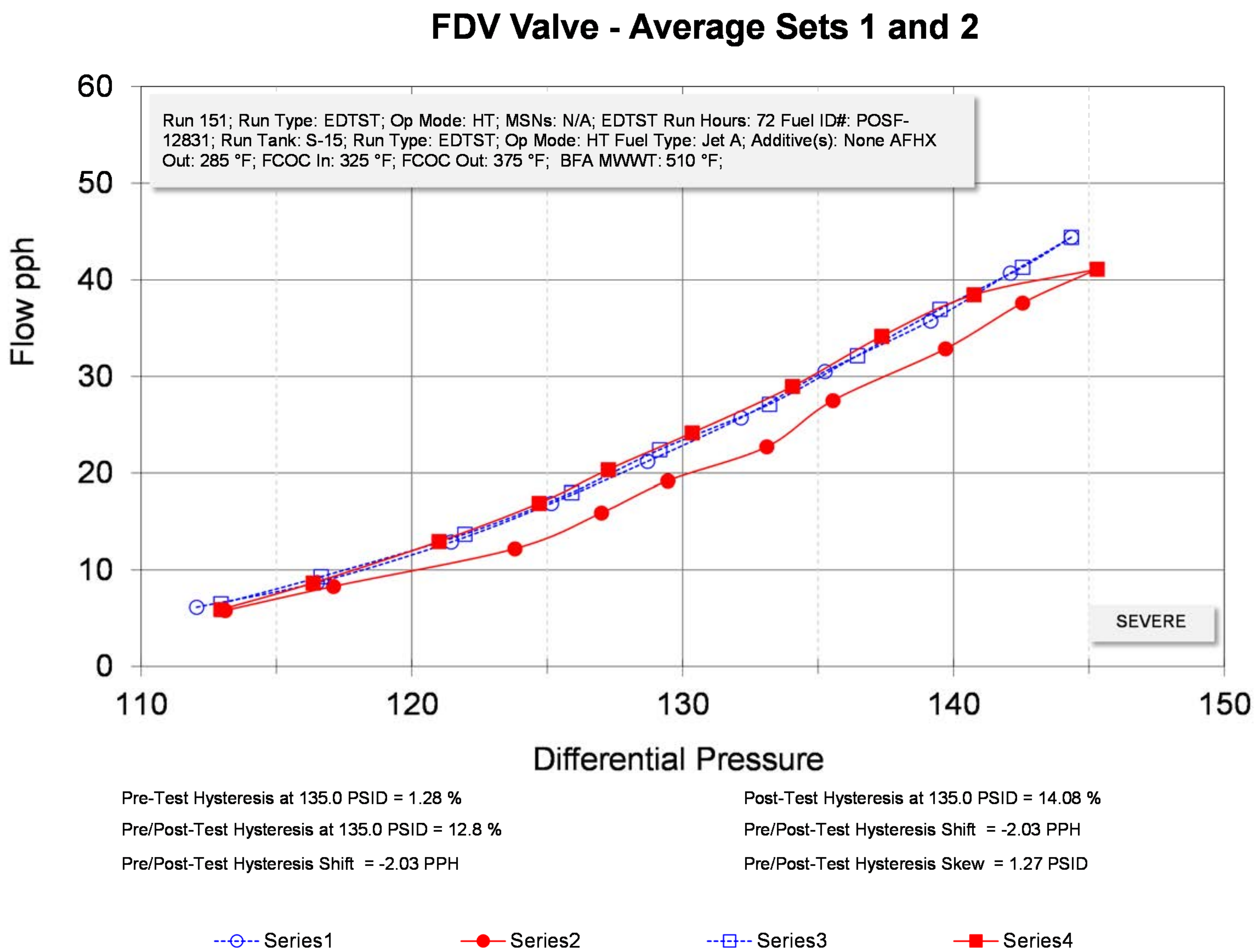


Figure H- 4 FDV Hysteresis

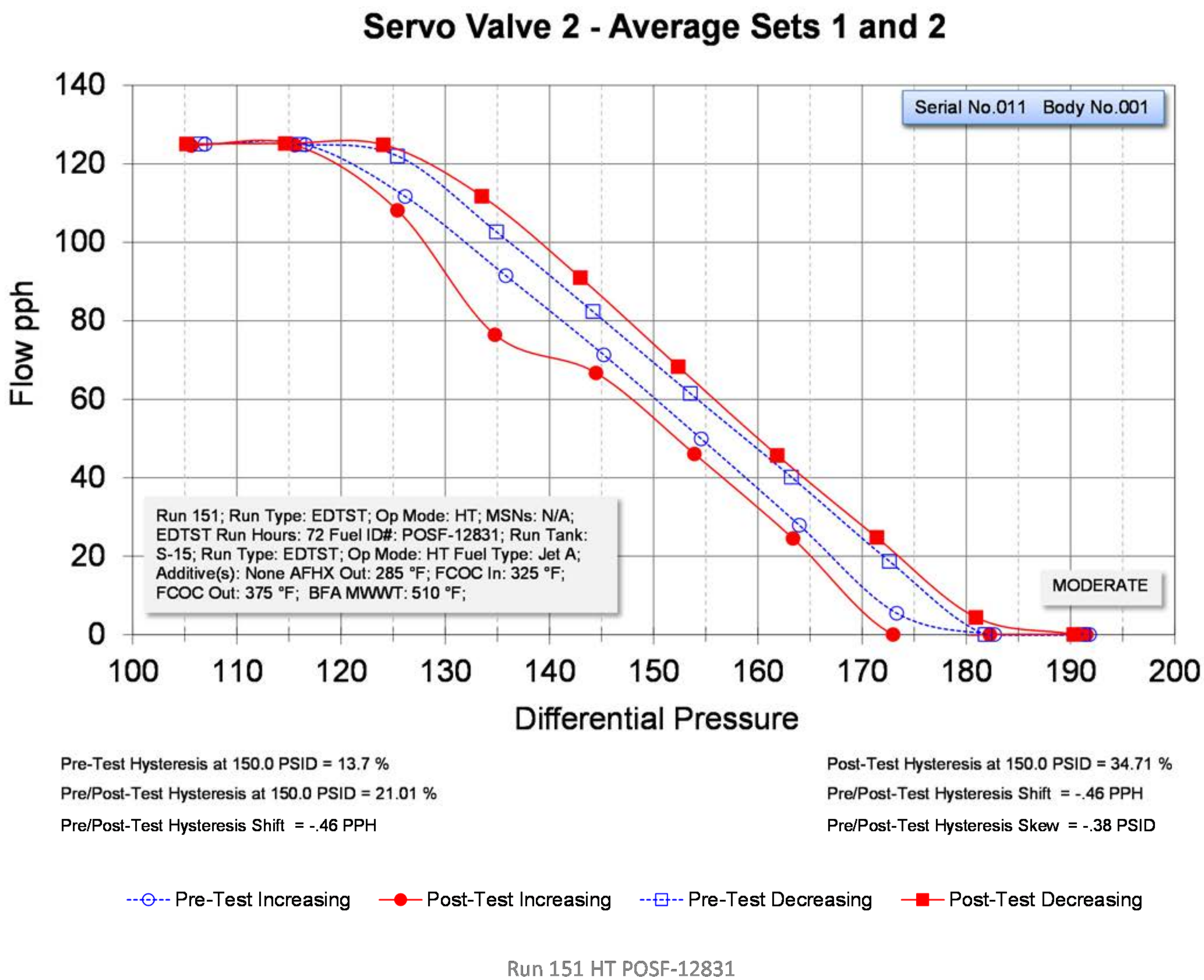


Figure H- 5 Servo Valve Hysteresis

FDV Components Comparison to Clean Run 151

Figure H- 6 FDV Components - Comparison to Clean

Servo Valve and Nozzle Screen Simulator Components – Comparison To Clean - Run 151

Clean

Run 151 HT POSF-12831

Figure H- 7 Servo Valve and Nozzle Screen Components - Comparison to Clean

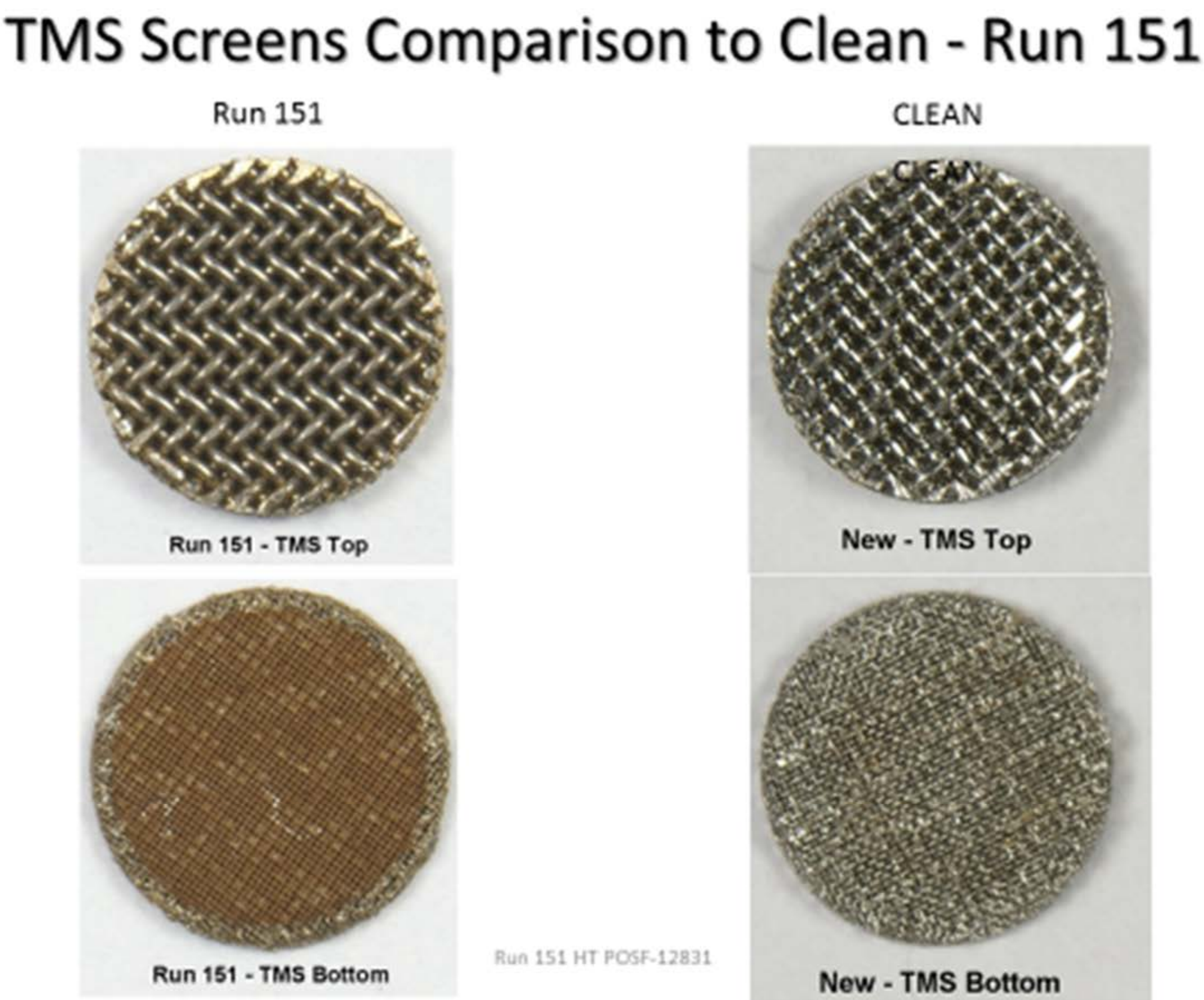


Figure H- 8 TMS Screen Top and Bottom - Comparison to Clean

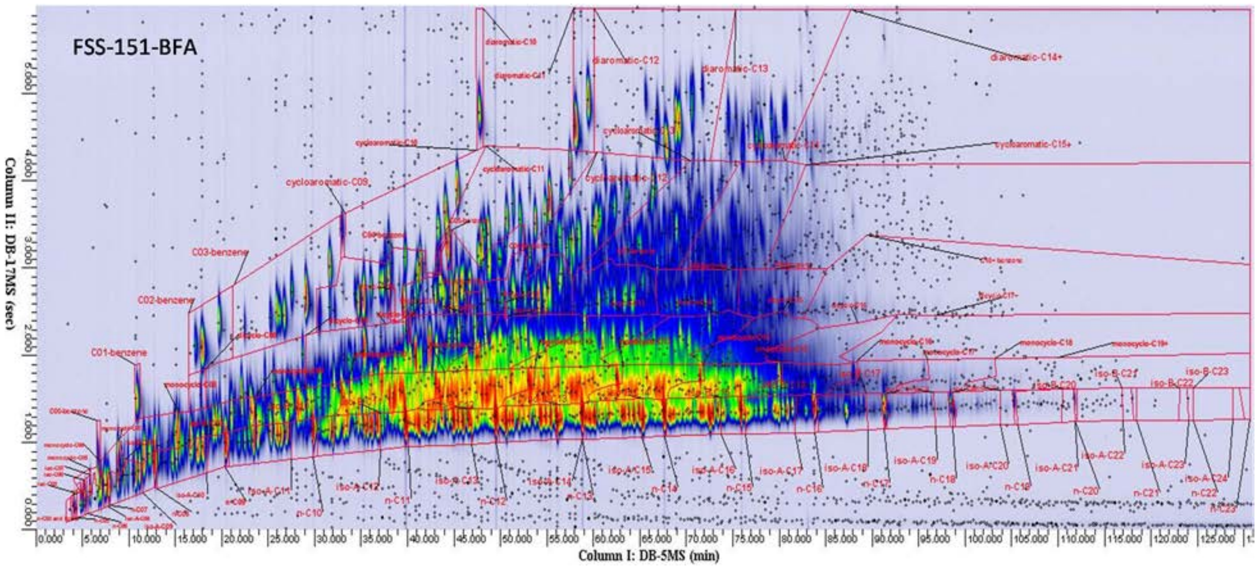


Figure H- 9 GCxGC Summary POSF-12831 BFA Outlet

Table H - 1 GCxGC Tabulated Data POSF-12831 Jet A Neat and Run 151 BFA Outlet

Hydrogen content (weight %)	13.9		13.9	
Average Molecular Wt (g/mole)	168		168	
	POSF-12831-Jet A Neat		**FSS151-BFA**	
	Weight %	**Volume %**	**Weight %**	**Volume %**
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	<0.01	<0.01
toluene (C07)	0.10	0.10	0.10	0.09
C2-benzene (C08)	0.42	0.39	0.42	0.39
C3-benzene (C09)	0.88	0.82	0.88	0.81
C4-benzene (C10)	1.47	1.37	1.48	1.38
C5-benzene (C11)	1.78	1.66	1.79	1.66
C6-benzene (C12)	1.69	1.58	1.69	1.57
C7-benzene (C13)	1.21	1.13	1.22	1.13
C8-benzene (C14)	0.99	0.92	0.98	0.91
C9-benzene (C15)	0.55	0.51	0.54	0.50
C10+-benzene (C16+)	0.24	0.23	0.23	0.22
Total Alkylbenzenes	**9.33**	**8.69**	**9.32**	**8.68**
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.11	0.08
diaromatic-C11	0.51	0.40	0.51	0.40
diaromatic-C12	0.96	0.77	0.95	0.76
diaromatic-C13	0.58	0.47	0.57	0.46
diaromatic-C14+	0.18	0.15	0.17	0.14
Total Alkylnaphthalenes	**2.33**	**1.87**	**2.31**	**1.85**
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.03	0.02	0.03	0.02
cycloaromatic-C10	0.53	0.44	0.53	0.44
cycloaromatic-C11	1.54	1.32	1.47	1.26
cycloaromatic-C12	1.67	1.45	1.72	1.50
cycloaromatic-C13	1.54	1.35	1.56	1.37
cycloaromatic-C14	0.94	0.83	0.95	0.83
cycloaromatics-C15+	0.30	0.26	0.28	0.24
Total Cycloaromatics	**6.56**	**5.67**	**6.53**	**5.65**
Total Aromatics	**18.22**	**16.24**	**18.17**	**16.19**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.24	0.29	0.24	0.29
C08-isoparaffins	0.43	0.49	0.43	0.50
C09-isoparaffins	0.58	0.65	0.66	0.74
C10-isoparaffins	1.46	1.61	1.50	1.65
C11-isoparaffins	2.76	2.99	2.79	3.02
C12-isoparaffins	4.56	4.94	4.57	4.95
C13-isoparaffins	4.75	5.04	4.96	5.25
C14-isoparaffins	4.49	4.72	4.31	4.53
C15-isoparaffins	3.64	3.81	3.61	3.77
C16-isoparaffins	1.50	1.55	1.47	1.53
C17-isoparaffins	0.46	0.47	0.45	0.46
C18-isoparaffins	0.15	0.16	0.13	0.14
C19-isoparaffins	0.08	0.08	0.08	0.08
C20-isoparaffins	0.05	0.05	0.04	0.04
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01

n-Paraffins				
n-C07 & lower	0.19	0.22	0.19	0.22
n-C08	0.38	0.49	0.38	0.49
n-C09	0.56	0.65	0.56	0.63
n-C10	1.00	1.10	1.02	1.12
n-C11	2.89	3.13	2.92	3.17
n-C12	3.11	3.35	3.15	3.36
n-C13	2.77	2.94	2.76	2.98
n-C14	2.38	2.50	2.34	2.46
n-C15	1.40	1.46	1.39	1.46
n-C16	0.34	0.36	0.35	0.36
n-C17	0.12	0.13	0.13	0.14
n-C18	0.04	0.04	0.04	0.04
n-C19	0.02	0.02	0.02	0.02
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	15.22	16.30	15.23	16.31
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.49	0.51	0.49	0.51
C08-monocycloparaffins	0.71	0.72	0.69	0.70
C09-monocycloparaffins	1.49	1.51	1.44	1.46
C10-monocycloparaffins	2.56	2.52	2.58	2.58
C11-monocycloparaffins	5.59	5.68	5.70	5.75
C12-monocycloparaffins	5.49	5.49	5.51	5.52
C13-monocycloparaffins	5.81	5.75	5.77	5.71
C14-monocycloparaffins	4.05	4.01	4.03	4.00
C15-monocycloparaffins	2.58	2.55	2.63	2.60
C16-monocycloparaffins	0.93	0.92	0.91	0.90
C17-monocycloparaffins	0.73	0.72	0.71	0.70
C18-monocycloparaffins	0.06	0.06	0.06	0.06
C19+-monocycloparaffins	0.07	0.08	0.09	0.08
Total Monocycloparaffins	29.82	29.73	29.84	29.74
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.27	0.25	0.30	0.28
C10-dicycloparaffins	0.71	0.64	0.75	0.67
C11-dicycloparaffins	2.49	2.78	2.95	2.72
C12-dicycloparaffins	2.60	2.46	2.68	2.58
C13-dicycloparaffins	2.89	2.75	2.94	2.78
C14-dicycloparaffins	1.89	1.78	1.76	1.67
C15-dicycloparaffins	0.63	0.59	0.57	0.54
C16-dicycloparaffins	0.04	0.08	0.09	0.08
C17+-dicycloparaffins	0.09	0.08	0.02	0.02
Total Dicycloparaffins	11.50	10.81	11.44	10.75
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.07	0.06	0.07	0.06
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	0.08	0.06	0.07	0.06
Total Cycloparaffins	41.40	40.61	41.35	40.55
Average Molecular Formula-C	12.1		12.0	
Average Molecular Formula-H	23.2		23.2	

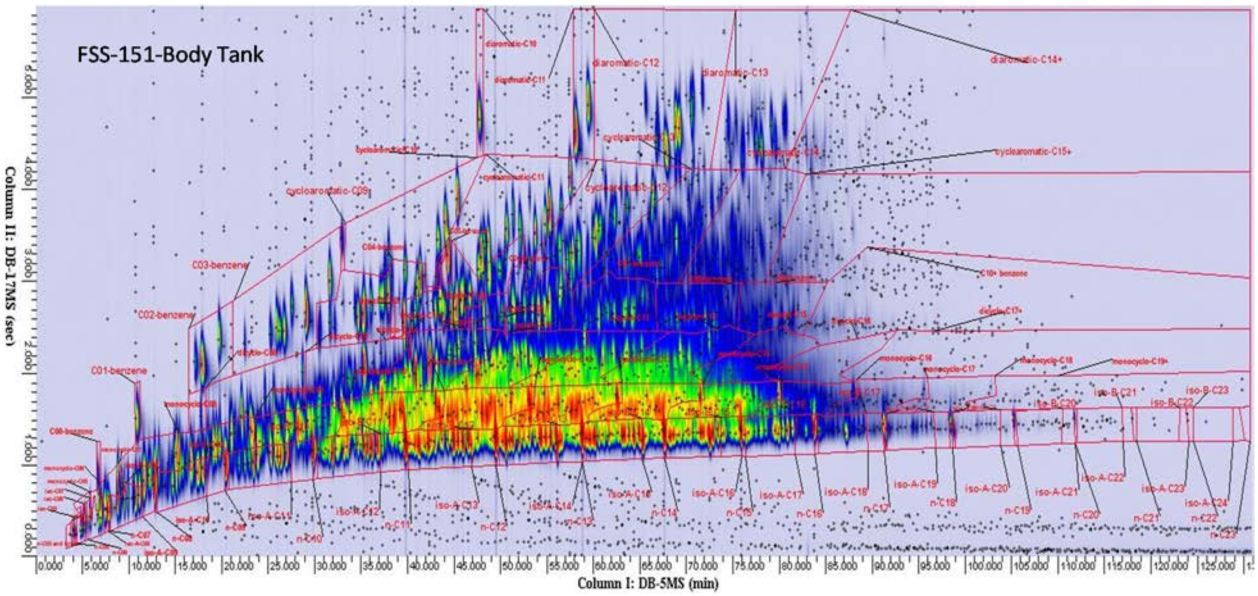


Figure H- 10 GCxGC Summary Fuel From Body Tank

Table H - 2 GCxGC Tabulated Data - Fuel From Body Tank at the End Of Run

	POSF-12831-Jet A Neat		FSS151-Body Tar	
Hydrogen content (weight %)	13.9		13.9	
Average Molecular Wt (g/mole)	168		168	
	Weight %	Volume %	Weight %	Volume %
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	<0.01	<0.01
toluene (C07)	0.10	0.10	0.10	0.09
C2-benzene (C08)	0.42	0.39	0.41	0.38
C3-benzene (C09)	0.88	0.82	0.87	0.81
C4-benzene (C10)	1.47	1.37	1.47	1.37
C5-benzene (C11)	1.78	1.66	1.78	1.65
C6-benzene (C12)	1.69	1.58	1.67	1.56
C7-benzene (C13)	1.21	1.13	1.21	1.13
C8-benzene (C14)	0.99	0.92	1.00	0.94
C9-benzene (C15)	0.55	0.51	0.58	0.54
C10+-benzene (C16+)	0.24	0.23	0.23	0.21
Total Alkylbenzenes	**9.33**	8.69	**9.33**	8.69
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.11	0.08
diaromatic-C11	0.51	0.40	0.50	0.40
diaromatic-C12	0.96	0.77	0.95	0.76
diaromatic-C13	0.58	0.47	0.58	0.47
diaromatic-C14+	0.18	0.15	0.17	0.14
Total Alkylnaphthalenes	**2.33**	1.87	**2.31**	1.85
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.03	0.02	0.03	0.02
cycloaromatic-C10	0.53	0.44	0.53	0.44
cycloaromatic-C11	1.54	1.32	1.47	1.26
cycloaromatic-C12	1.67	1.45	1.74	1.51
cycloaromatic-C13	1.54	1.35	1.55	1.36
cycloaromatic-C14	0.94	0.83	0.95	0.83
cycloaromatics-C15+	0.30	0.26	0.30	0.26
Total Cycloaromatics	**6.56**	5.67	**6.57**	5.69
Total Aromatics	**18.22**	**16.24**	**18.20**	**16.23**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.24	0.29	0.24	0.28
C08-isoparaffins	0.43	0.49	0.41	0.47
C09-isoparaffins	0.58	0.65	0.64	0.72
C10-isoparaffins	1.46	1.61	1.44	1.59
C11-isoparaffins	2.76	2.99	2.74	2.96
C12-isoparaffins	4.56	4.94	4.46	4.84
C13-isoparaffins	4.75	5.04	4.84	5.13
C14-isoparaffins	4.49	4.72	4.52	4.75
C15-isoparaffins	3.64	3.81	3.62	3.78
C16-isoparaffins	1.50	1.55	1.51	1.57
C17-isoparaffins	0.46	0.47	0.46	0.47
C18-isoparaffins	0.15	0.16	0.14	0.15
C19-isoparaffins	0.08	0.08	0.07	0.07
C20-isoparaffins	0.05	0.05	0.04	0.05
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01
n-Paraffins				
n-C07 & lower	0.19	0.22	0.18	0.22
n-C08	0.38	0.43	0.37	0.43
n-C09	0.56	0.62	0.55	0.61
n-C10	1.00	1.10	1.01	1.11
n-C11	2.89	3.13	2.89	3.13
n-C12	3.11	3.32	3.15	3.37
n-C13	2.77	2.94	2.78	2.95
n-C14	2.38	2.50	2.34	2.46
n-C15	1.40	1.46	1.42	1.48
n-C16	0.34	0.36	0.35	0.36
n-C17	0.12	0.13	0.14	0.14
n-C18	0.04	0.04	0.04	0.04
n-C19	0.02	0.02	0.02	0.02
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**15.22**	16.30	**15.25**	16.32
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.49	0.51	0.50	0.52
C08-monocyclocycloparaffins	0.71	0.72	0.67	0.69
C09-monocyclocycloparaffins	1.49	1.51	1.47	1.49
C10-monocyclocycloparaffins	2.36	2.32	2.35	2.31
C11-monocyclocycloparaffins	5.59	5.63	5.59	5.63
C12-monocyclocycloparaffins	5.49	5.49	5.53	5.53
C13-monocyclocycloparaffins	5.81	5.75	5.76	5.70
C14-monocyclocycloparaffins	4.05	4.02	4.03	4.00
C15-monocyclocycloparaffins	2.58	2.55	2.61	2.58
C16-monocyclocycloparaffins	0.93	0.92	0.94	0.93
C17-monocyclocycloparaffins	0.23	0.22	0.20	0.20
C18-monocyclocycloparaffins	0.06	0.06	0.06	0.06
C19+-monocyclocycloparaffins	0.04	0.03	0.04	0.04
Total Monocycloparaffins	**29.82**	29.73	**29.75**	29.66
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.27	0.25	0.27	0.25
C10-dicycloparaffins	0.71	0.64	0.74	0.66
C11-dicycloparaffins	2.43	2.28	2.43	2.29
C12-dicycloparaffins	2.60	2.46	2.60	2.45
C13-dicycloparaffins	2.89	2.73	2.91	2.75
C14-dicycloparaffins	1.89	1.78	1.95	1.84
C15-dicycloparaffins	0.63	0.59	0.59	0.55
C16-dicycloparaffins	0.04	0.03	0.04	0.03
C17+-dicycloparaffins	0.03	0.03	0.03	0.03
Total Dicycloparaffins	**11.50**	10.81	**11.57**	10.88
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.07	0.06	0.07	0.06
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.08**	0.06	**0.07**	0.06
Total Cycloparaffins	**41.40**	40.61	**41.40**	40.60
Average Molecular Formula - C	12.1		12.1	
Average Molecular Formula - H	23.2		23.2	

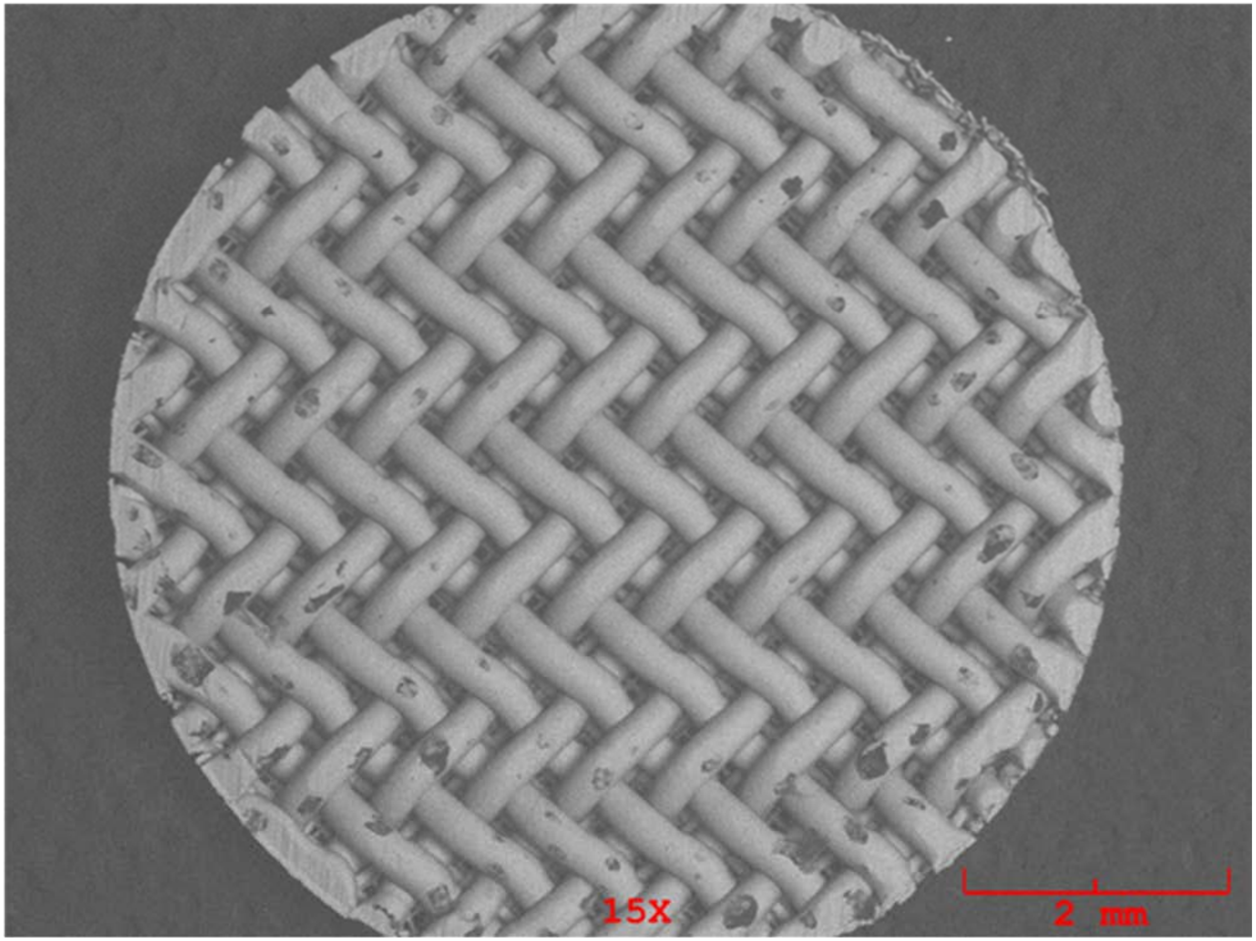
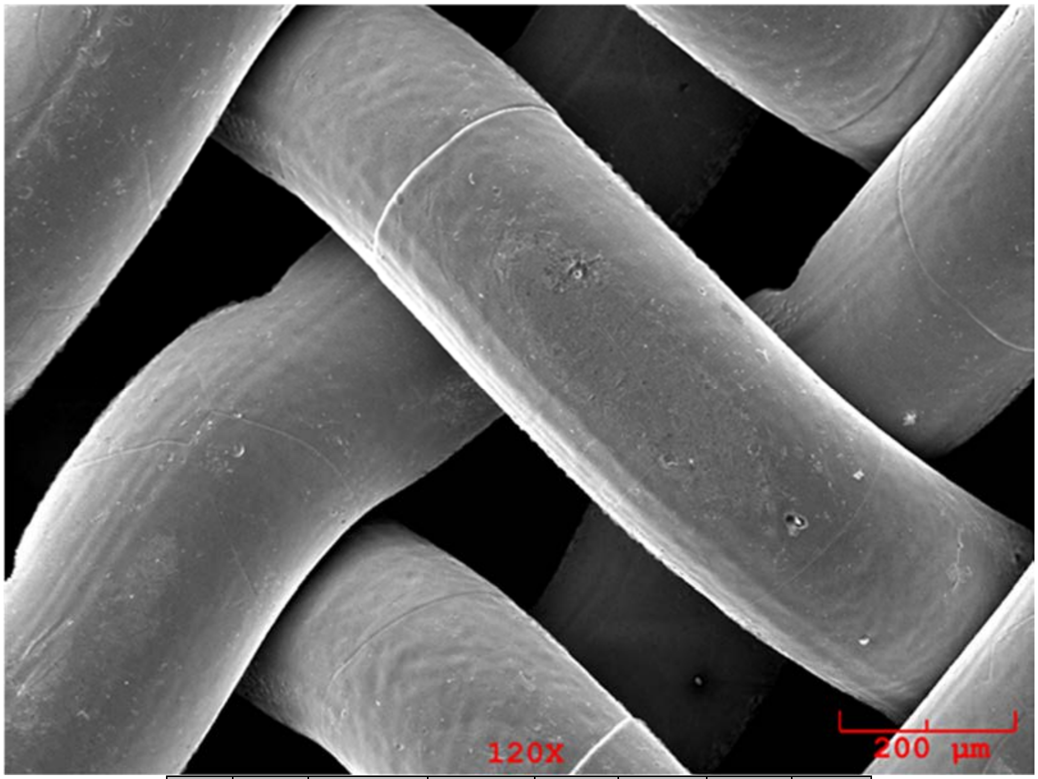


Figure H- 11 TMS Screen, Top, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	3.57	1.899	wt.%	0.328	0.396	
Al	Ka	3.75	0.505	wt.%	0.121	0.167	
Si	Ka	4.26	0.461	wt.%	0.102	0.141	
S	Ka	6.49	0.549	wt.%	0.087	0.116	
Cr	Ka	152.31	17.725	wt.%	0.304	0.151	
Fe	Ka	358.68	69.295	wt.%	0.749	0.247	
Ni	Ka	33.09	9.566	wt.%	0.387	0.304	
			100.000	wt.%			Total

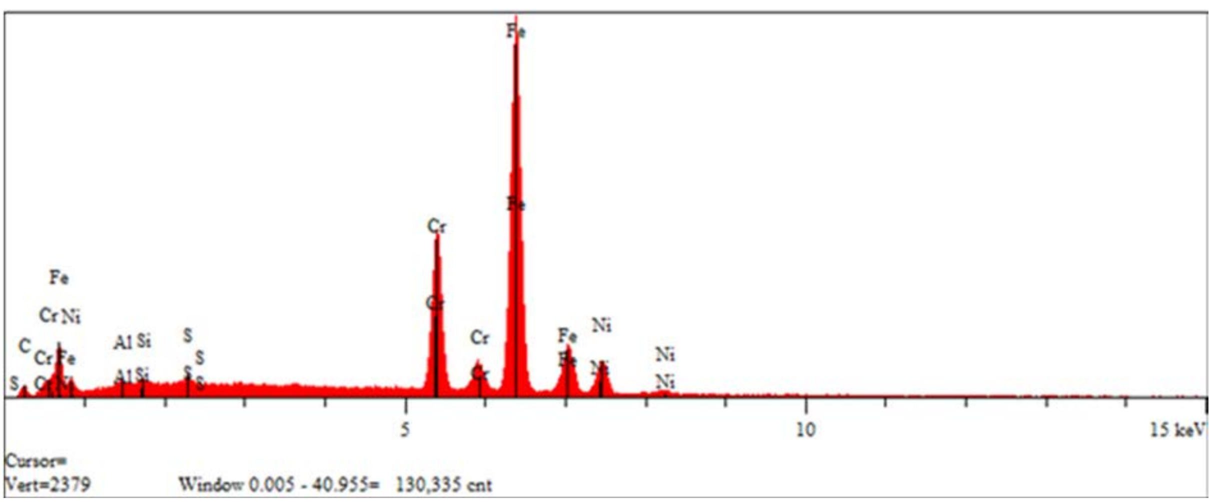


Figure H- 12 TMS Screen Top, 120X and EDX Elemental Analysis

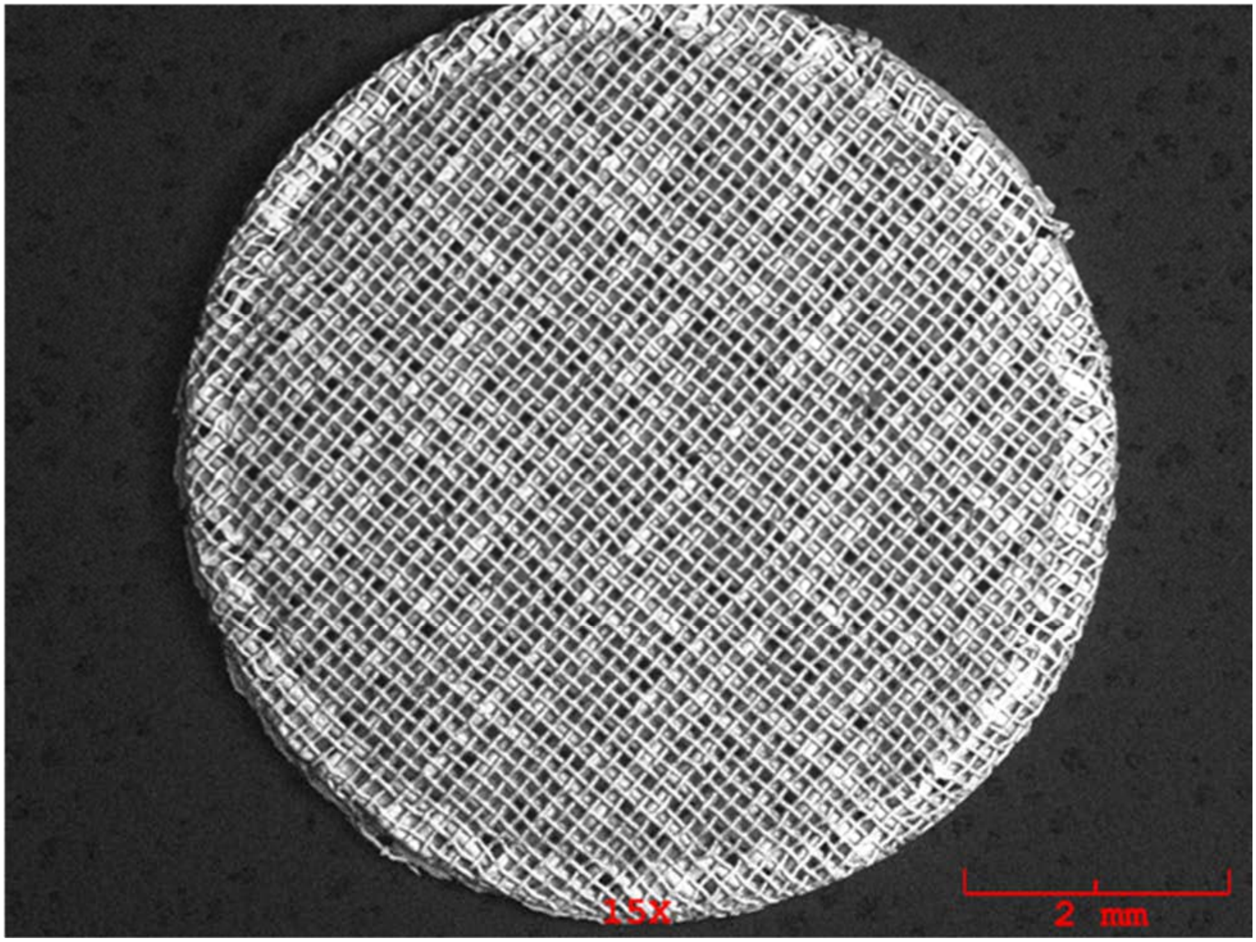
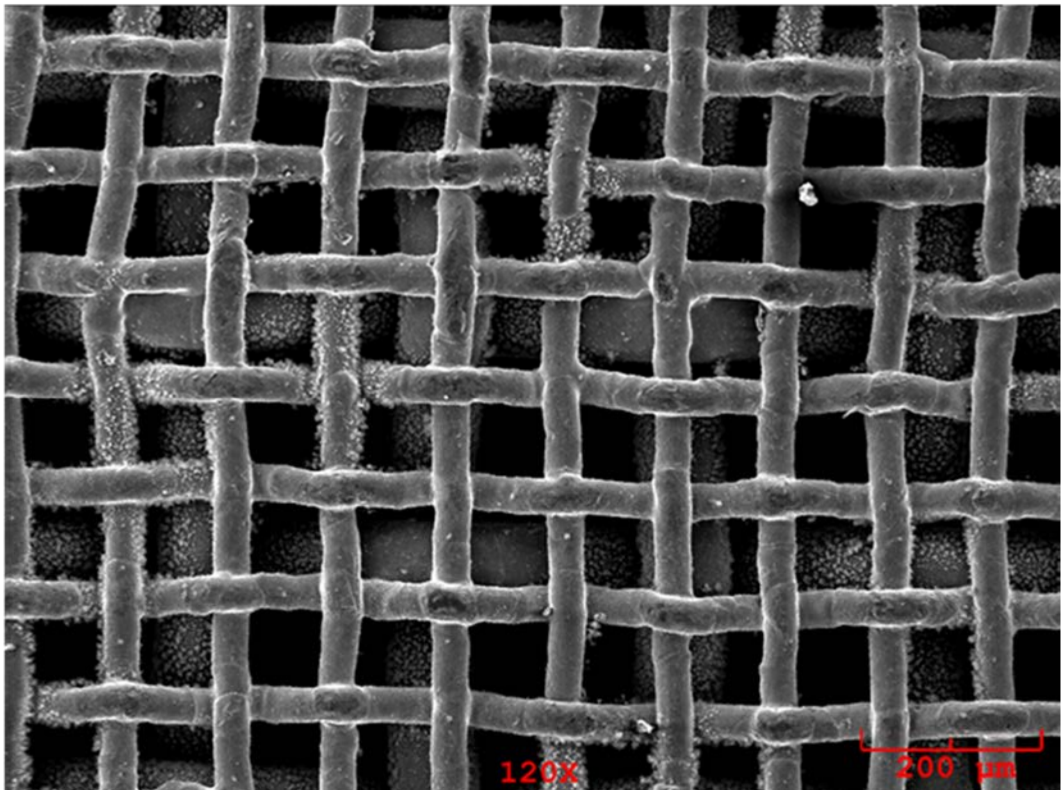


Figure H- 13 TMS Screen, Bottom, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	11.36	5.630	wt.%	0.477	0.521	
Al	Ka	6.70	0.789	wt.%	0.118	0.155	
Si	Ka	4.33	0.413	wt.%	0.095	0.131	
S	Ka	30.08	2.274	wt.%	0.110	0.110	
Cr	Ka	168.85	18.204	wt.%	0.298	0.155	
Fe	Ka	370.12	65.415	wt.%	0.699	0.245	
Ni	Ka	27.72	7.275	wt.%	0.338	0.297	
			100.000	wt.%			Total

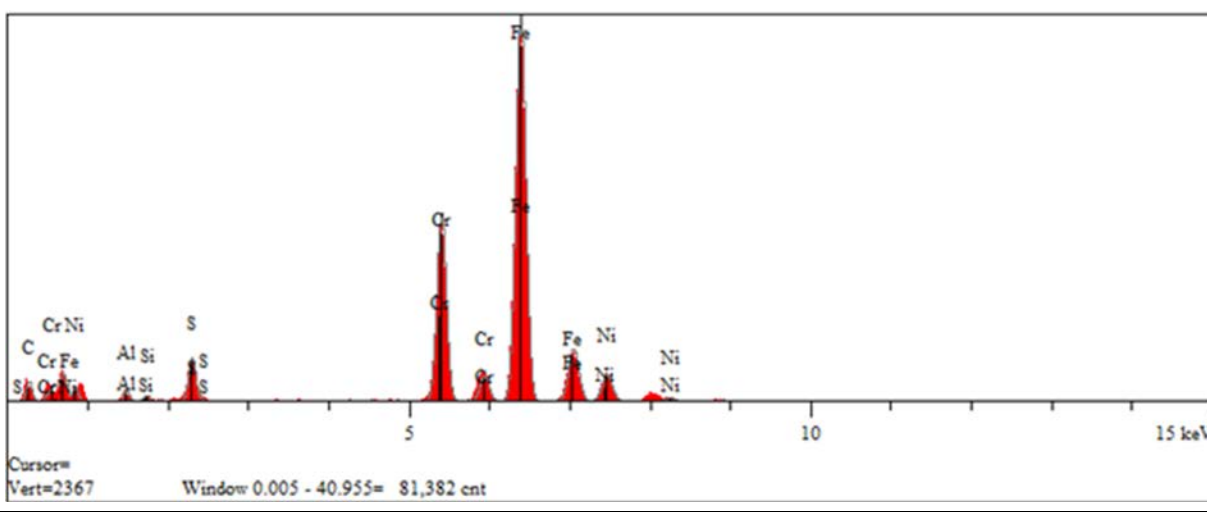


Figure H- 14 TMS Screen, Bottom, 120X and EDX Elemental Analysis

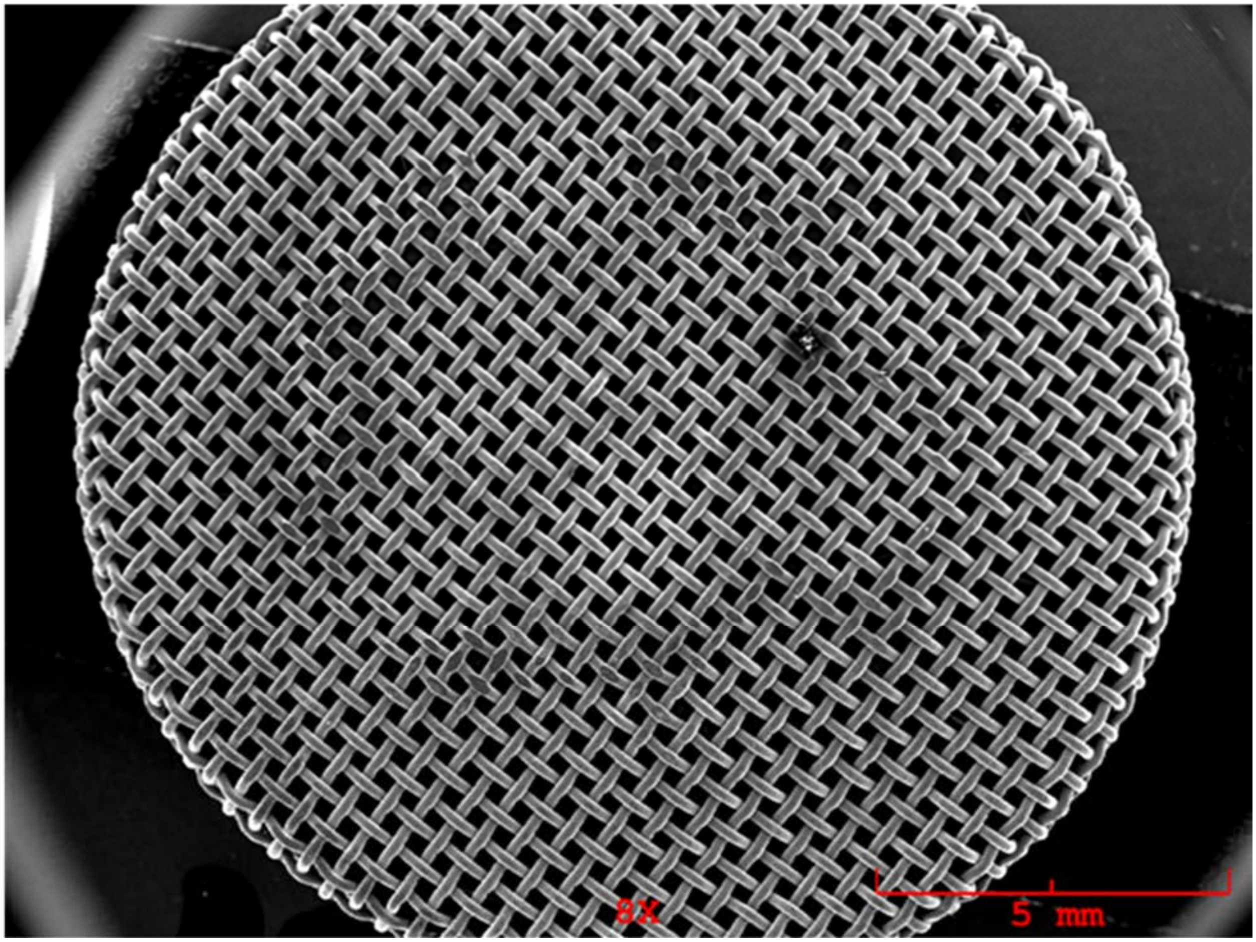
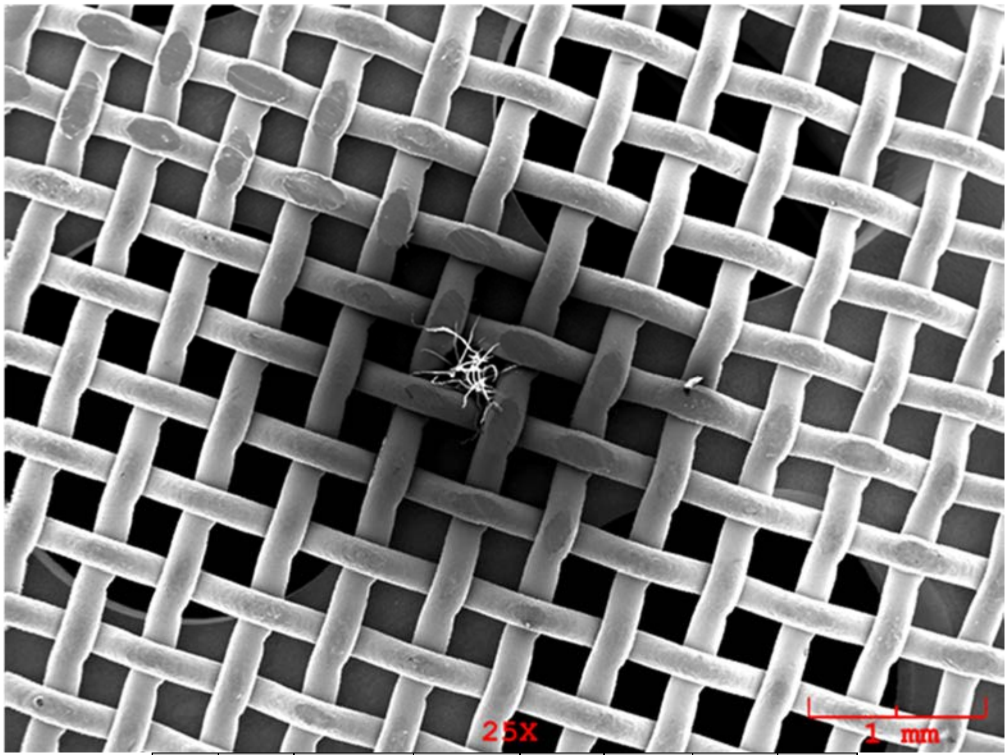


Figure H- 15 F303 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	5.93	2.539	wt.%	0.346	0.422	
Al	Ka	0.70	0.074	wt.%	0.099	0.148	
Si	Ka	6.17	0.523	wt.%	0.092	0.125	
S	Ka	20.31	1.353	wt.%	0.091	0.105	
Cr	Ka	184.93	16.992	wt.%	0.266	0.141	
Fe	Ka	451.79	68.901	wt.%	0.665	0.224	
Ni	Ka	42.13	9.618	wt.%	0.350	0.284	
			100.000	wt.%			Total

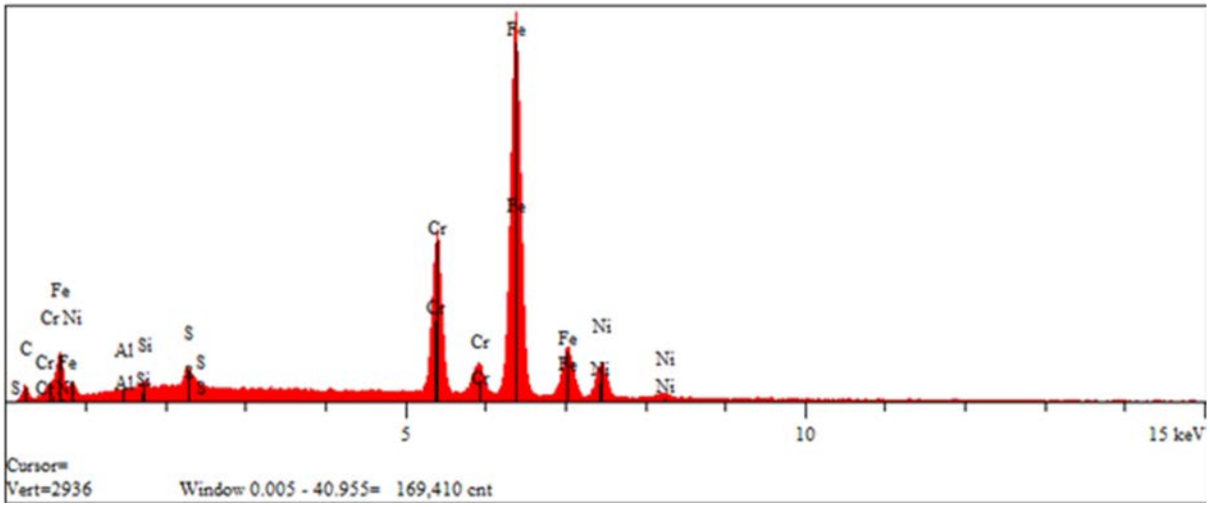


Figure H- 16 F303 Bottom 25X and EDX Elemental Analysis

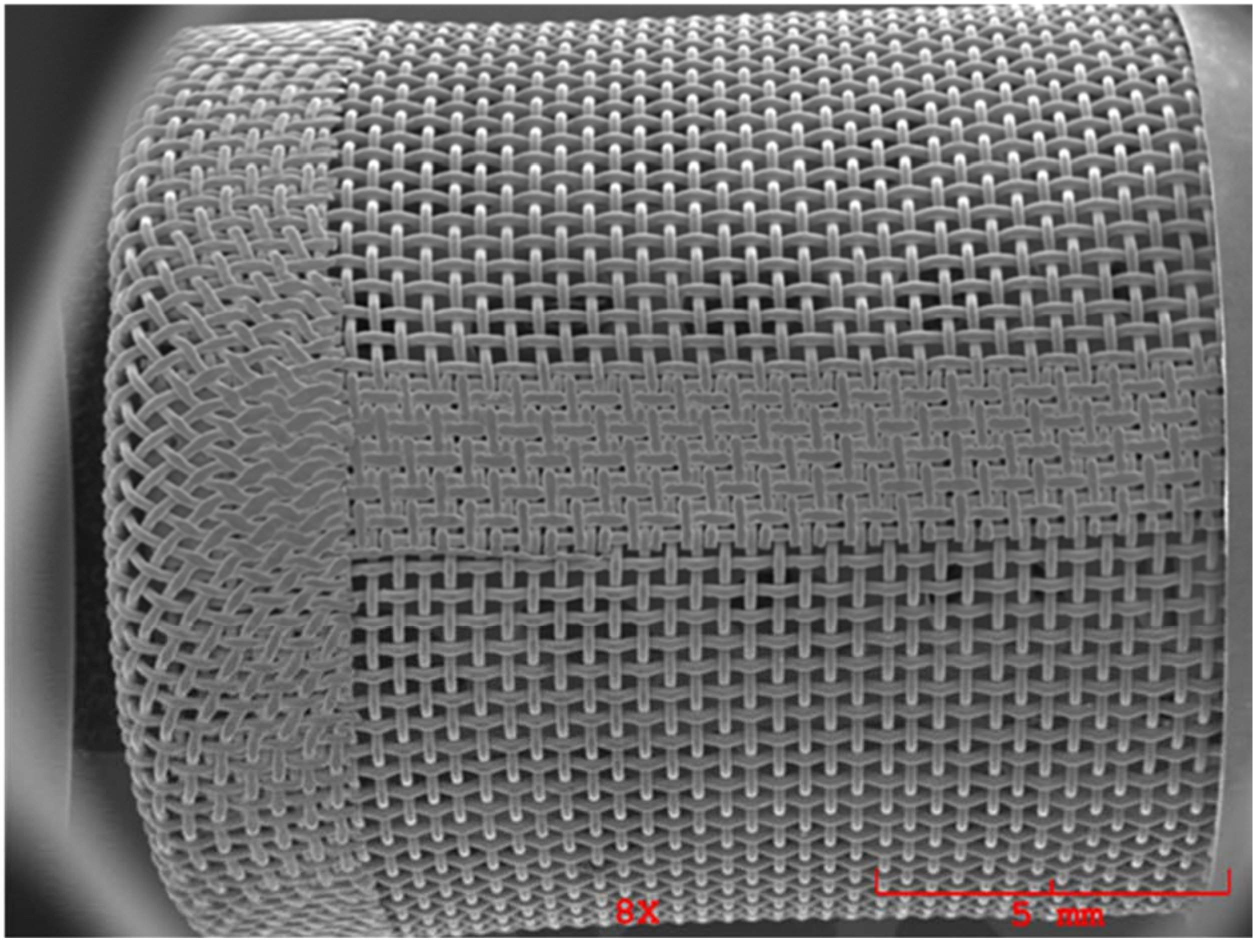
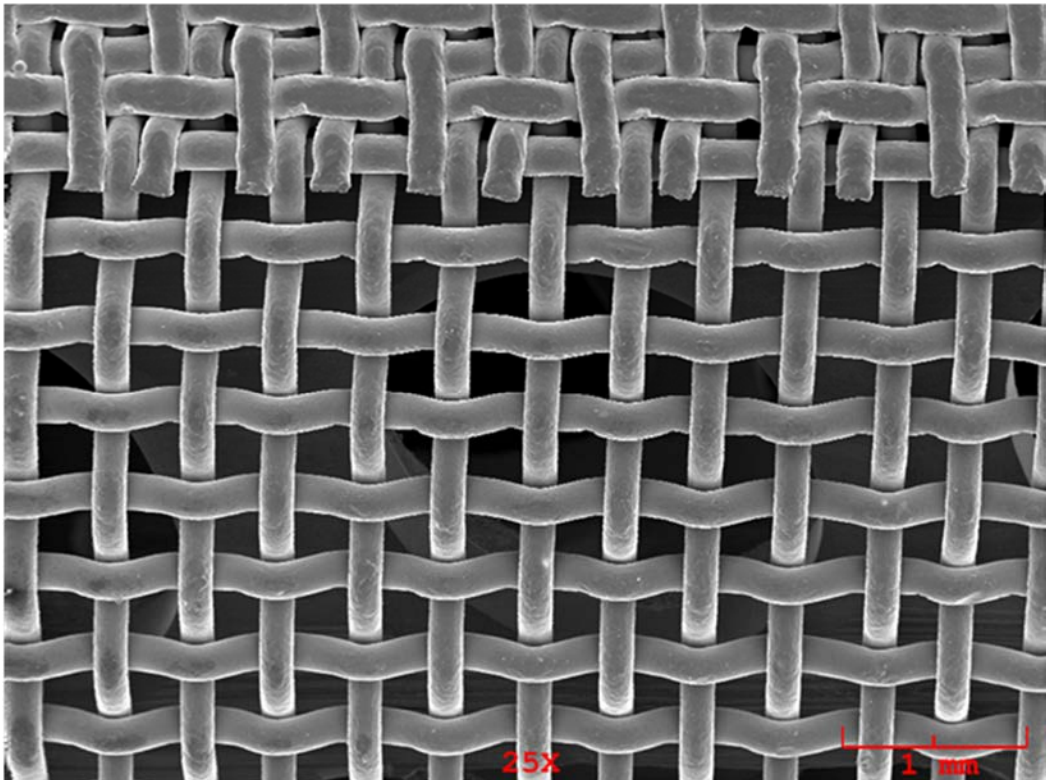


Figure H- 17 F303 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	7.10	2.692	wt.%	0.294	0.327	
Al	Ka	1.41	0.133	wt.%	0.092	0.137	
Si	Ka	6.29	0.475	wt.%	0.086	0.117	
S	Ka	20.49	1.214	wt.%	0.085	0.101	
Cr	Ka	206.82	16.886	wt.%	0.249	0.127	
Fe	Ka	506.48	68.626	wt.%	0.626	0.214	
Ni	Ka	49.17	9.975	wt.%	0.329	0.253	
			100.000	wt.%			Total

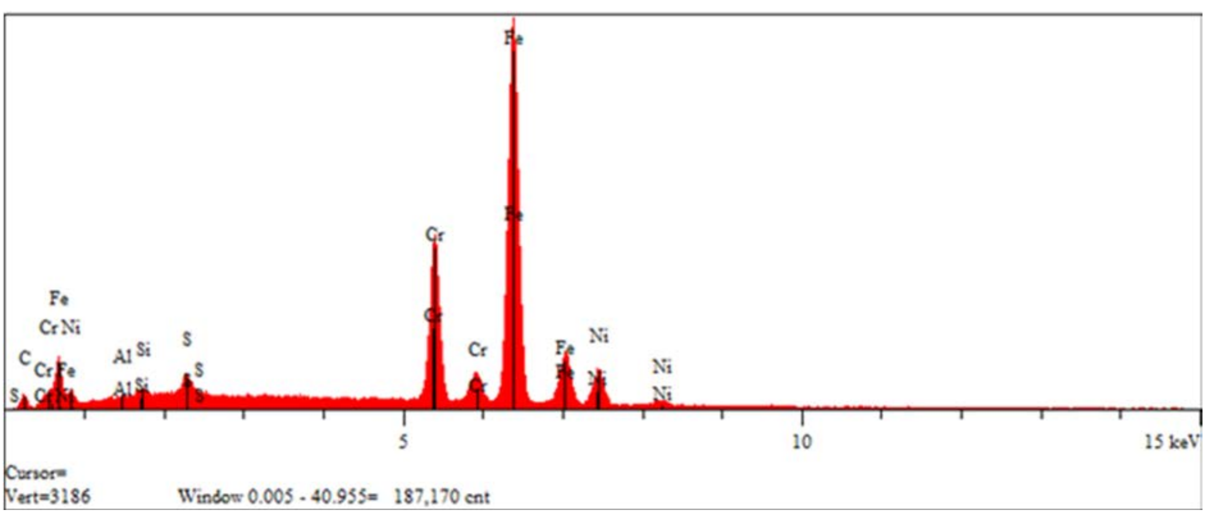


Figure H- 18 F303 Side 25X and EDX Elemental Analysis

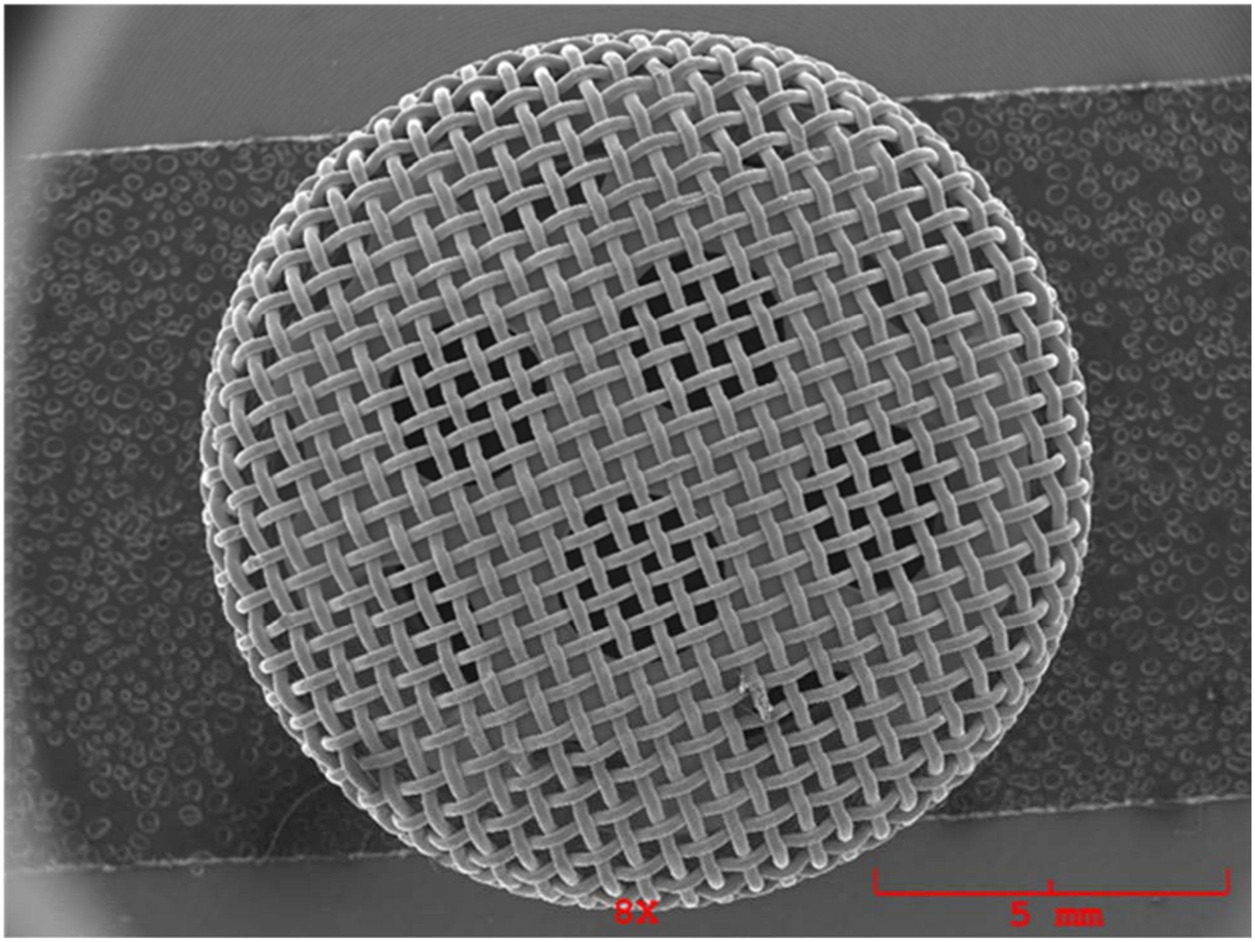
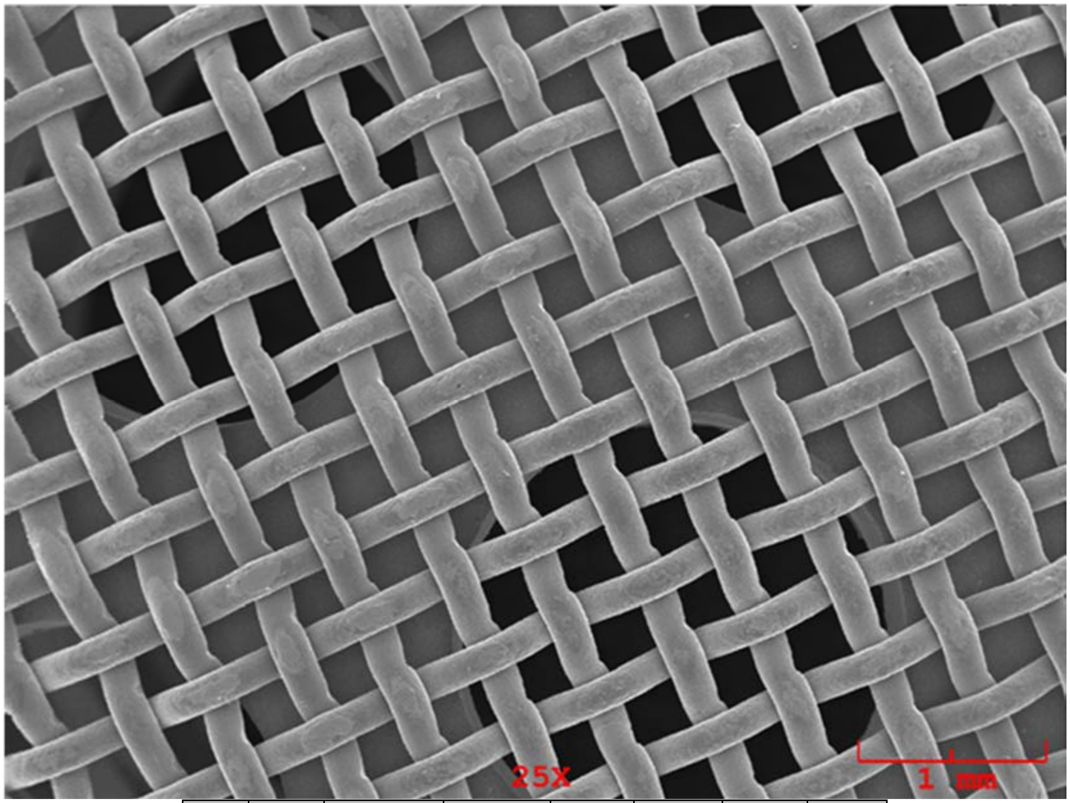


Figure H- 19 F304 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	3.57	3.161	wt.%	0.573	0.712	
Si	Ka	3.59	0.450	wt.%	0.111	0.154	
S	Ka	16.35	1.438	wt.%	0.105	0.118	
Cr	Ka	177.46	16.168	wt.%	0.256	0.126	
Fe	Ka	466.67	68.757	wt.%	0.650	0.204	
Ni	Ka	46.31	10.026	wt.%	0.338	0.254	
			100.000	wt.%			Total

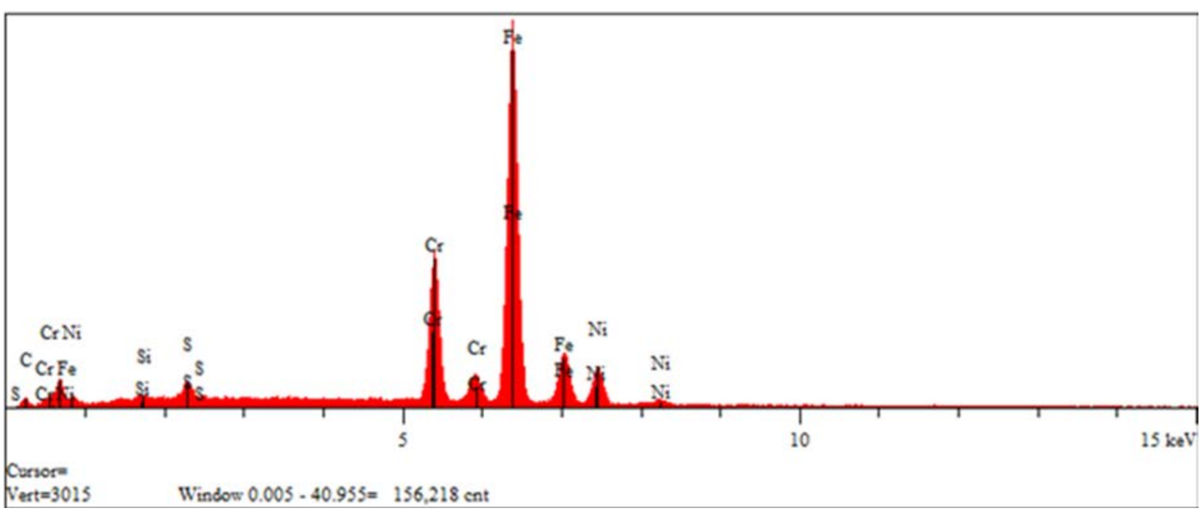


Figure H- 20 F304 Bottom, 25X and EDX Elemental Analysis

DISTRIBUTION STATEMENT A: Approved for public release. Distribution is unlimited.

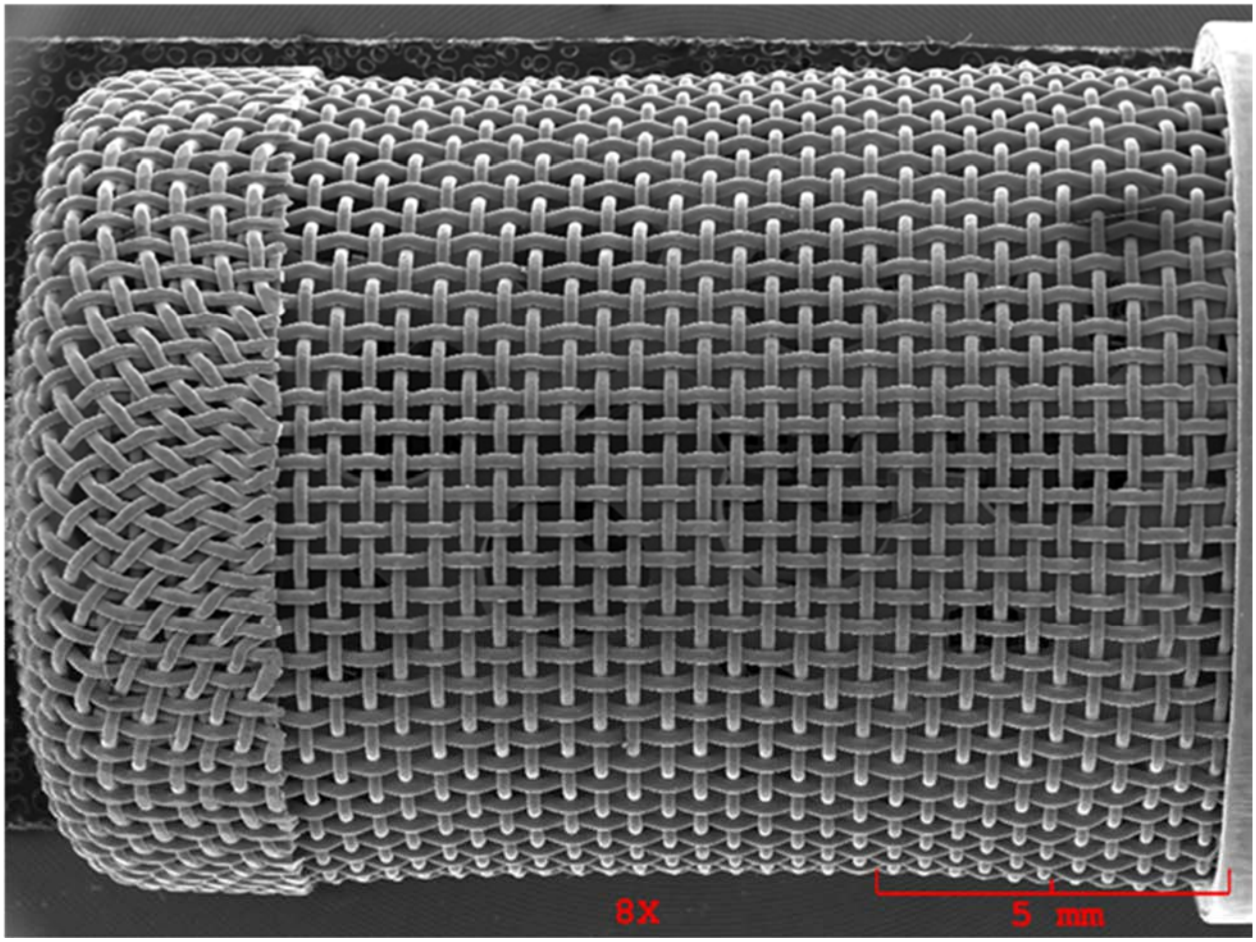
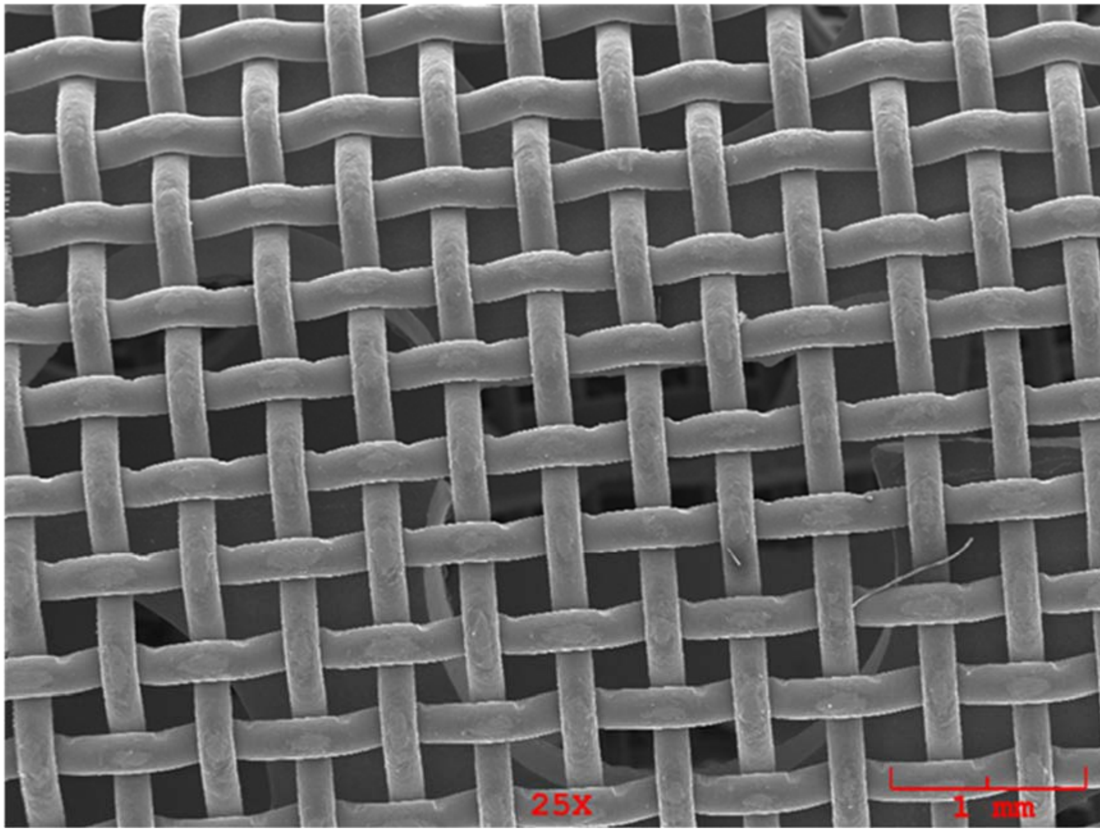


Figure H- 21 F304 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	1.81	1.825	wt.%	0.565	0.759	
Si	Ka	4.03	0.575	wt.%	0.123	0.166	
S	Ka	12.06	1.208	wt.%	0.109	0.128	
Cr	Ka	159.51	16.406	wt.%	0.275	0.136	
Fe	Ka	420.96	70.262	wt.%	0.700	0.218	
Ni	Ka	39.58	9.725	wt.%	0.356	0.272	
			100.000	wt.%			Total

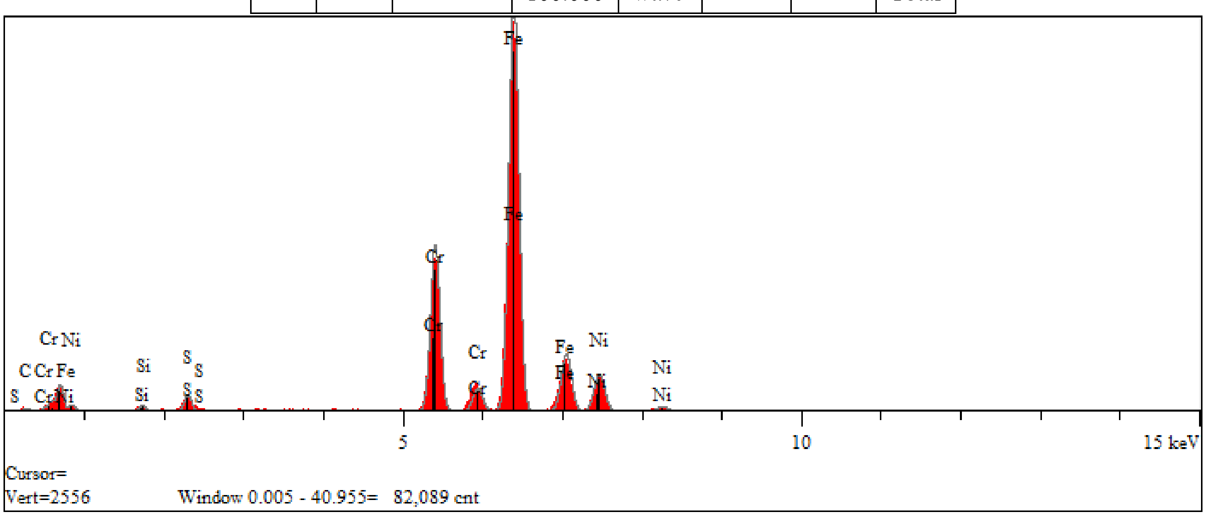


Figure H- 22 F304 Side, 25X and EDX Elemental Analysis

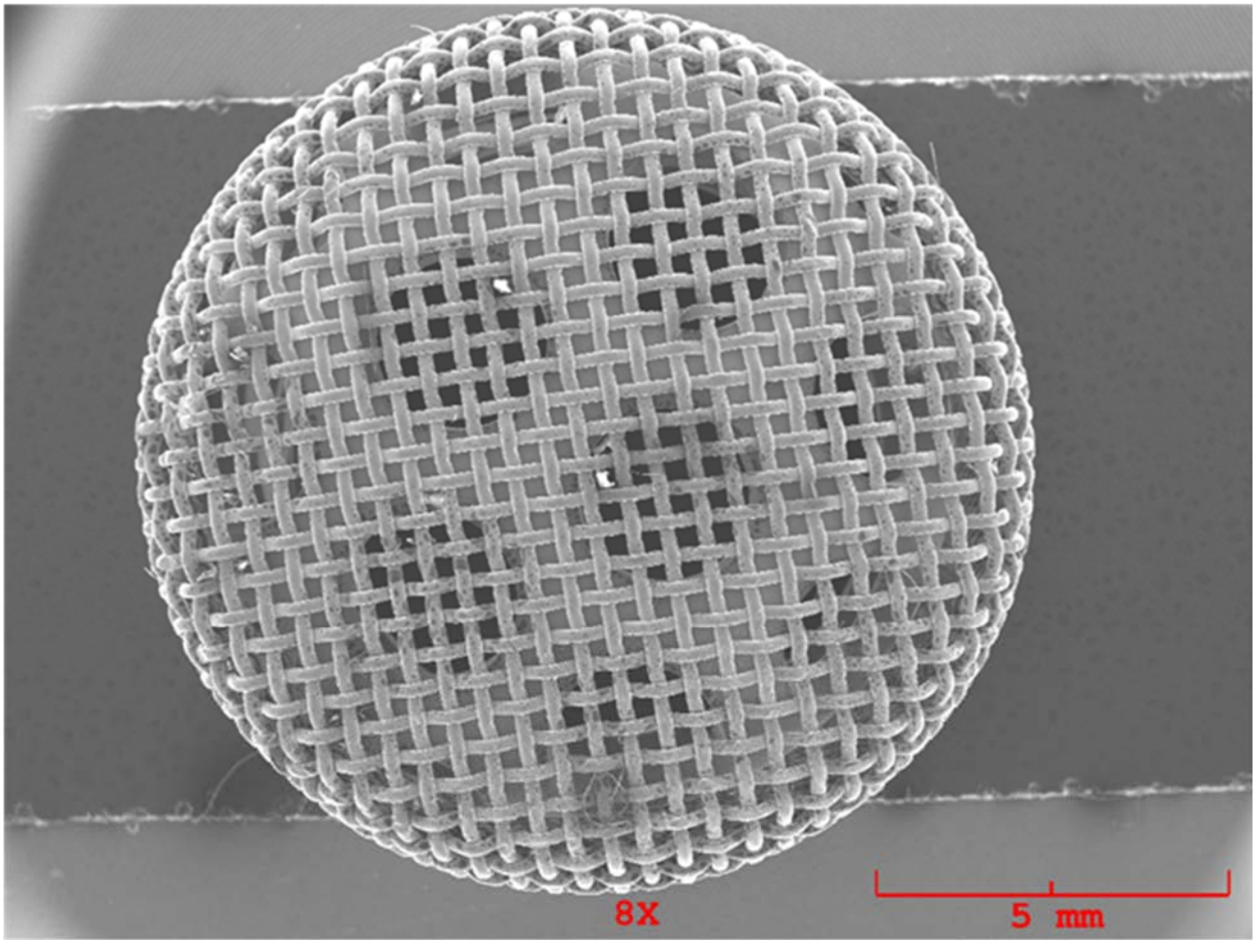
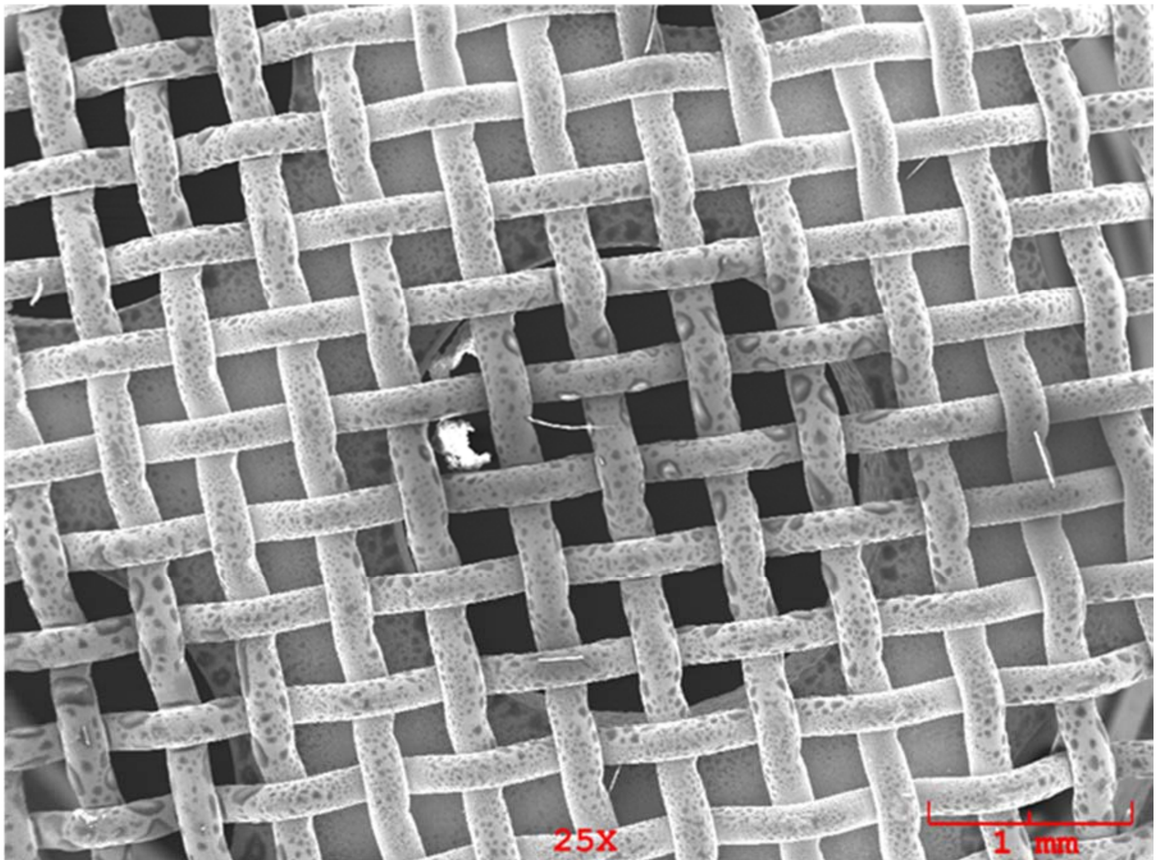


Figure H- 23 F702 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	11.44	12.874	wt.%	1.012	1.021	
Si	Ka	3.89	0.600	wt.%	0.118	0.155	
S	Ka	24.47	2.709	wt.%	0.137	0.126	
Cr	Ka	119.98	14.517	wt.%	0.280	0.140	
Fe	Ka	315.02	60.741	wt.%	0.701	0.229	
Ni	Ka	30.59	8.560	wt.%	0.357	0.274	
			100.000	wt.%			Total

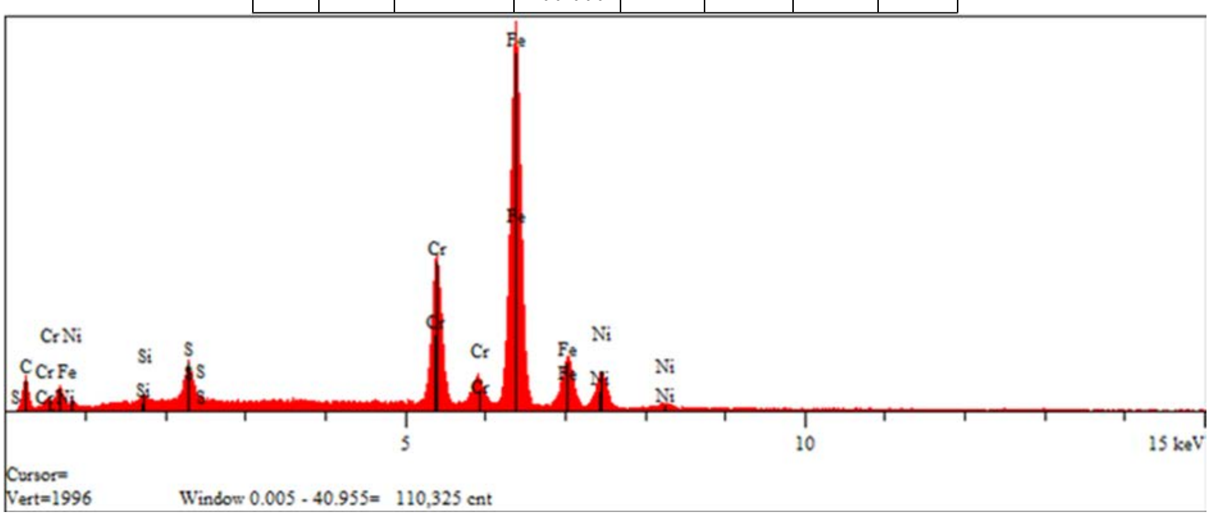


Figure H- 24 F702 Bottom, 25X and EDX Elemental Analysis

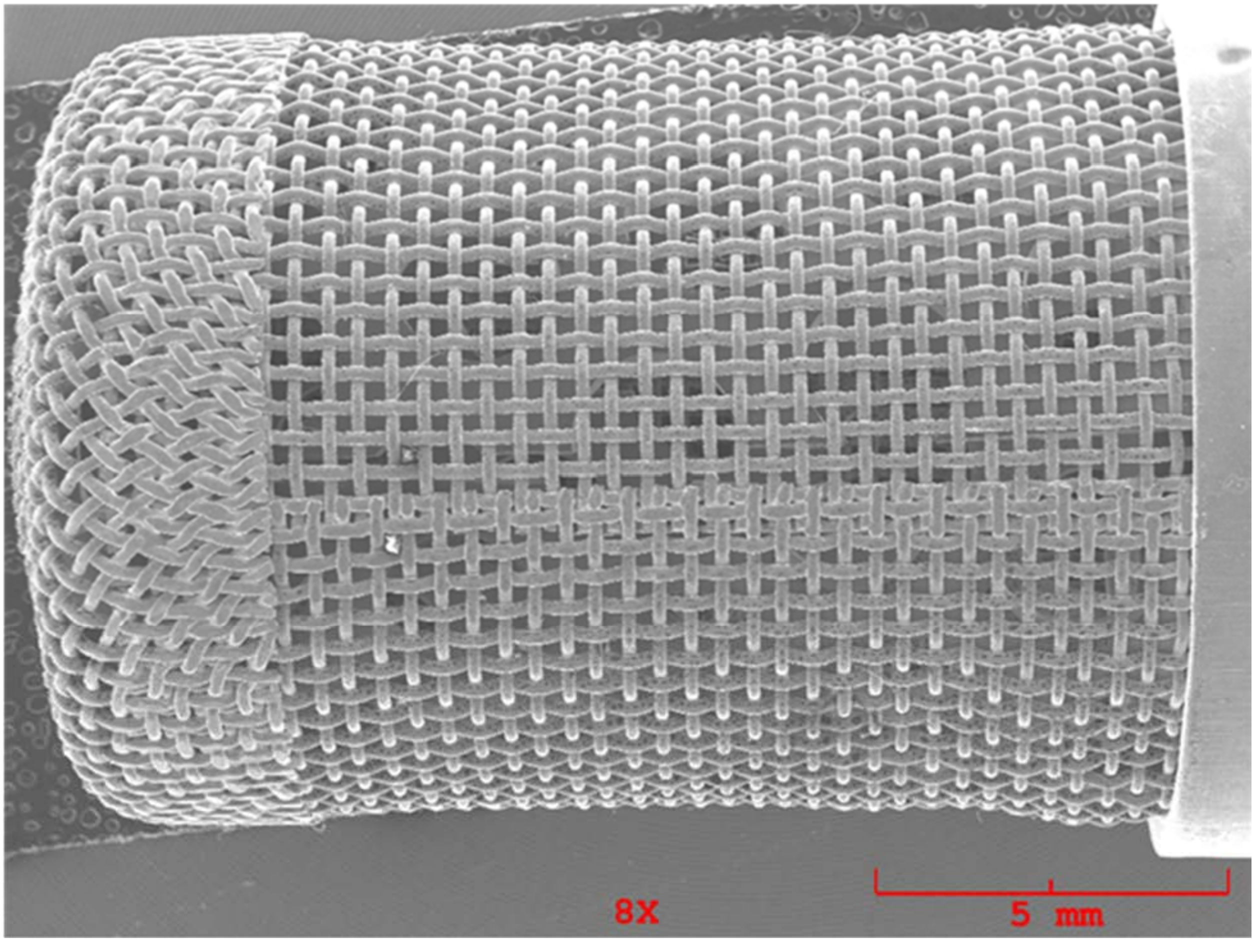
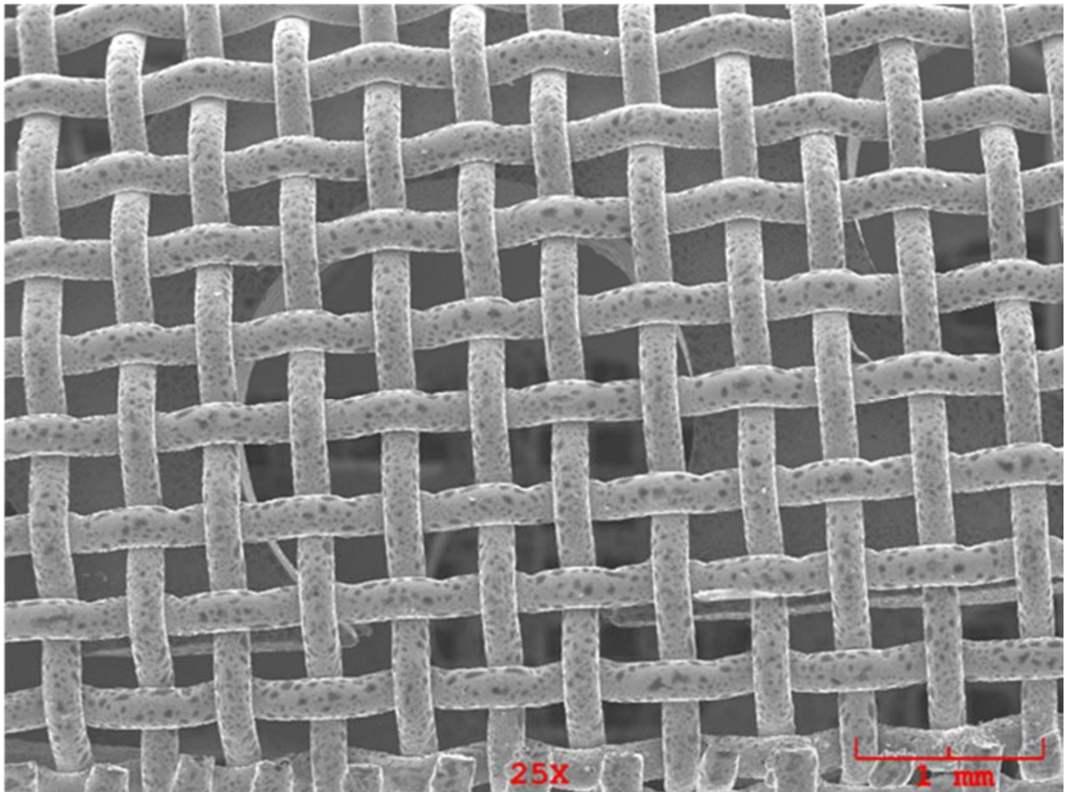


Figure H- 25 F702 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	7.32	12.381	wt.%	1.144	1.051	
Si	Ka	1.08	0.257	wt.%	0.143	0.205	
S	Ka	14.59	2.467	wt.%	0.168	0.164	
Cr	Ka	79.57	14.623	wt.%	0.347	0.175	
Fe	Ka	209.93	61.739	wt.%	0.870	0.269	
Ni	Ka	19.96	8.534	wt.%	0.442	0.340	
			100.000	wt.%			Total

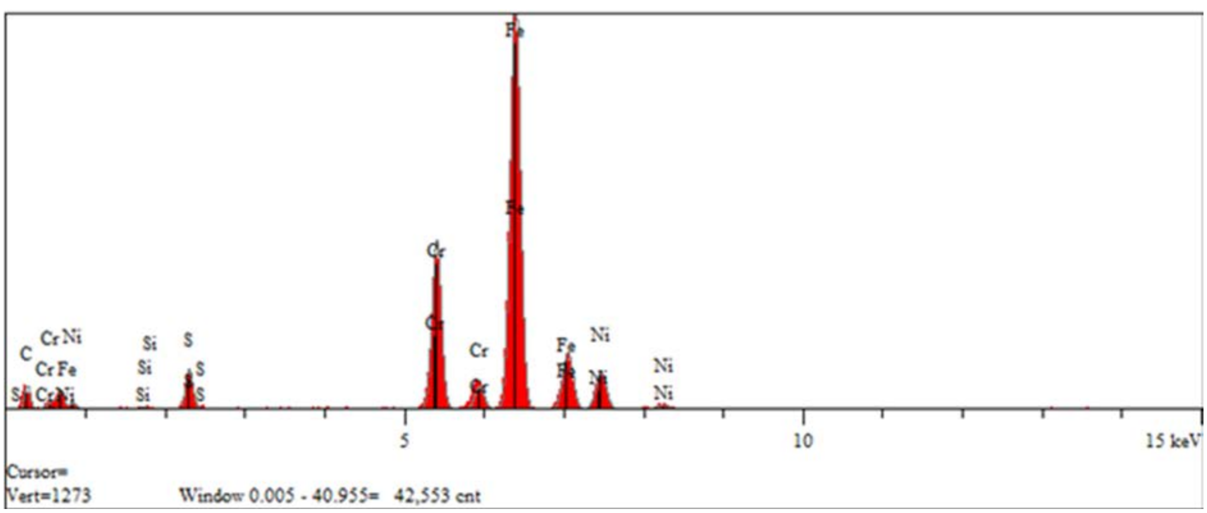


Figure H-26 F702 Side, 25X and EDX Elemental Analysis

APPENDIX I - RUN 153 DATA PACKAGE

Run Conditions: EDTST Mode, LT Conditions
Fuel ID: POSF-12843, Ft McCoy
Airframe Heat Exchanger Bulk Fuel Output: 285 °F
HP Pump HX Out/FCOC Bulk Fuel In: 300 °F
Fuel-Cooled Oil Cooler Bulk Fuel Output: 325 °F
Burner Feed Arm Max Wetted Wall Temperature: 510 °F
Run Duration: 72 Hours

DATA SUMMARY

Run 153; Run Type: EDTST; Op Mode: LT; EDTST Run Hours: 72 Fuel ID#: POSF-12843; Run Tank: S-3; Run Type: EDTST; Op Mode: LT Fuel Type: F-24; Additive(s): None AFHX Out: 285 °F; FCOC In: 300 °F; FCOC Out: 325 °F; BFA In: Report °F; BFA MWWT: 510 °F

Component/Device	Serial No.	Pre-Test %	Post-Test %	Spread (Pre/Post Delta), %	Shift, PPH	Skew, PSID	Flow Range Shift, PPH	Flow Midpoint Shift, PPH	Overall Rating	Hysteresis Area Change (PPH-DP)
FDV	1268	5.3	21.1	15.8	-0.6	-0.2	-2.9	-1.5	Moderate	71
Servo2	016	13.4	8.4	-5.0	-0.3	-0.5	0.2	0.1	None	-113

Effective Carbon - µgrams

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	50.6	53.9	55.0	43.0	47.6					
BFA	38.2	97.1	280.4	902.7	1093.6	1511.3	1812.2	1646.0	1246.2	738.7
Total FCOC Carbon, µgrams	250.1	µgrams	0.3	mgrams						
Total BFA Carbon, µgrams	9366.4	µgrams	9.4	mgrams						

SCREENS	Total Carbon, µg	Background Carbon, µg	Effective Carbon, µg	MWWT Start	MWWT End	Delta BFA MWWT	TE	BFA AWWT Start	BFA AWWT End	Delta BFA AWWT
TMS	27.1	0.3	26.8	510.56	524.29	13.73	MAX	493.69	500.47	6.78
F303	123.4	25.4	98.0	505.19	511.34	6.15	TE325	SV Inlet	FDV Inlet	BFA Inlet
F304	75.6	12.9	62.7	509.55	520.10	10.56	TE324	(TE702)	(TE313)	(TE316)
F305	0.0	0.0	0.0	510.56	524.29	13.73	TE323	316	304	302
F702	148.3	12.9	135.4	507.81	520.81	12.99	TE322			

Effective Carbon Deposition - µgrams/cm^2

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	13.9	14.8	15.1	11.8	13.0					
BFA	22.2	56.4	162.7	524.0	634.8	877.2	1051.9	955.4	723.4	428.8

TMS Mass Change - grams

Component/Device	Tare, g	Mass, g	Mass Gain, g
TMS	0.08622	0.08626	0.00004
F303	7.15914	7.15649	-0.00265
F304	3.06904	3.05044	-0.01860
F305	0.00000	0.00000	0.00000
F702	3.04422	3.03877	-0.00545

Hysteresis Ratings:
- NONE: indicating that the pre-test and post-test hysteresis curves, for all intents and purposes, are nearly indistinguishable from one another. Minor differences may be seen between the pre-test and post-test curves but these are very small.
- Minor: There are small differences between per- and post-test curves. The spread for these curves is typically within 5% of one another. There may be some small changes in shift and skew for the valve. This degree of hysteresis would not be expected to alter the functional nature of the valve.
- Moderate: There are definite differences between pre-and post-test curves. There may be definite differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically between 5% and 15%. This degree of hysteresis might be expected to alter the functional nature of the valve.
- Severe: There are pronounce differences between pre-and post-test curves. There may be pronounced differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically in excess 15%. This degree of hysteresis would be considered out-of-spec for the valve.
- Non-Functional: There are major differences between pre-and post-test curves. There may be major differences in shift and skew as well. The hysteresis curve will exhibit flat segments (either vertically or horizontally). Shift and skew have majorly changed the performance envelope of the valve. This degree of hysteresis would cause the valve to be non-functional or unresponsive over small or large portions of the performance range of the valve.

Figure I - 1 Run 153 Data Summary

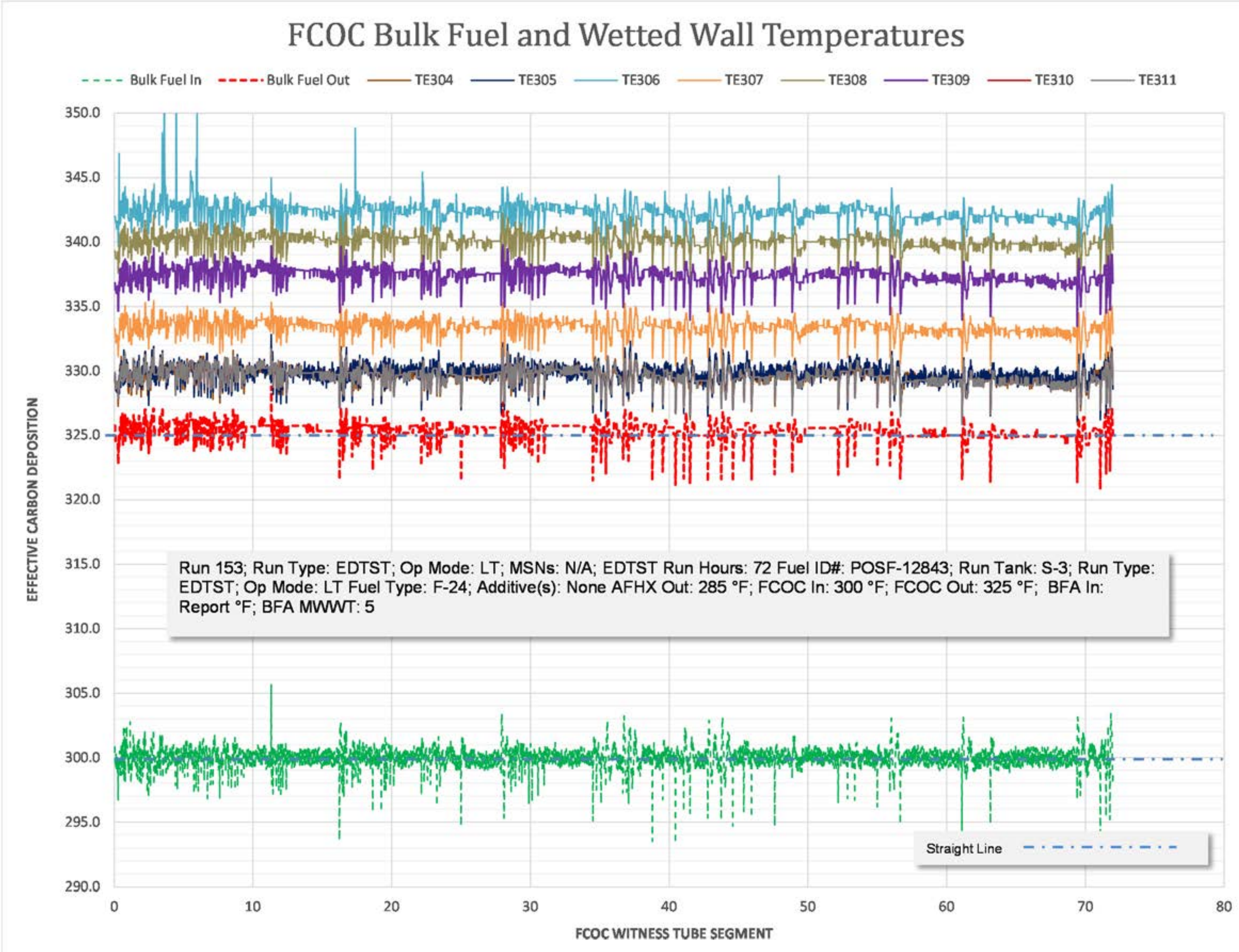


Figure I - 2 FCOC Bulk Fuel and Wetted Wall Temperatures

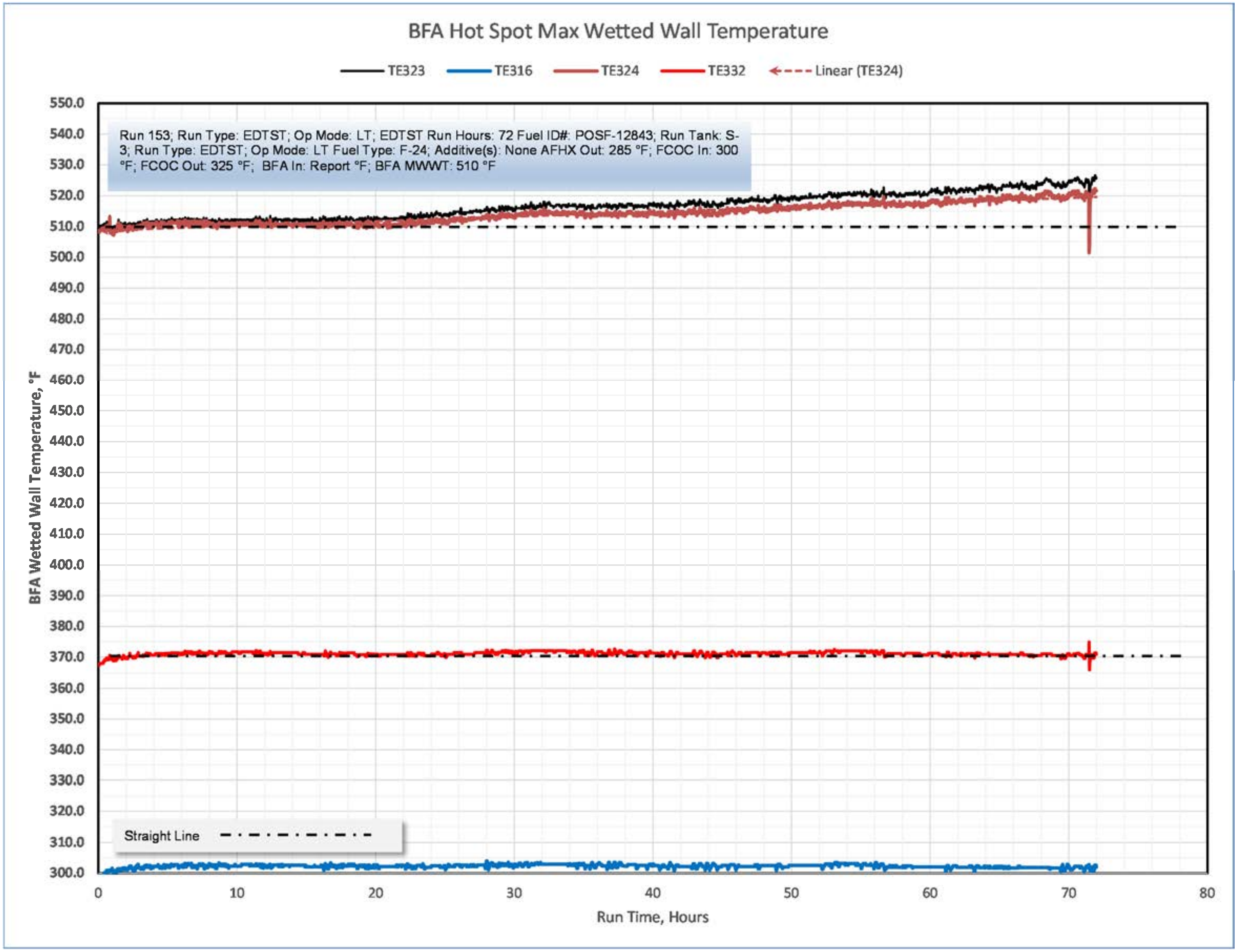


Figure I - 3 BFA Hot Spot Max Wetted Wall And Bulk Fuel Temperatures

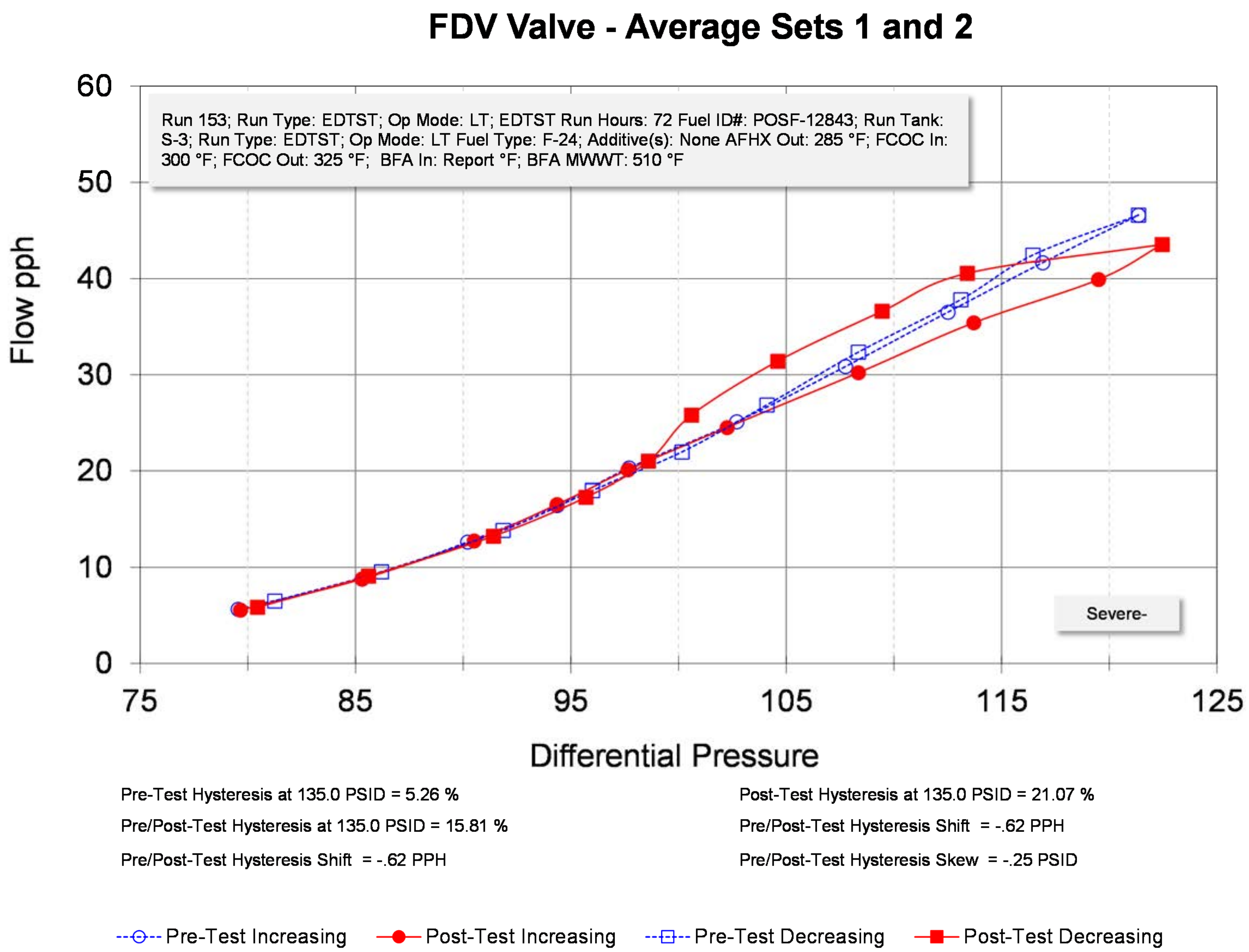


Figure I - 4 FDV Hysteresis

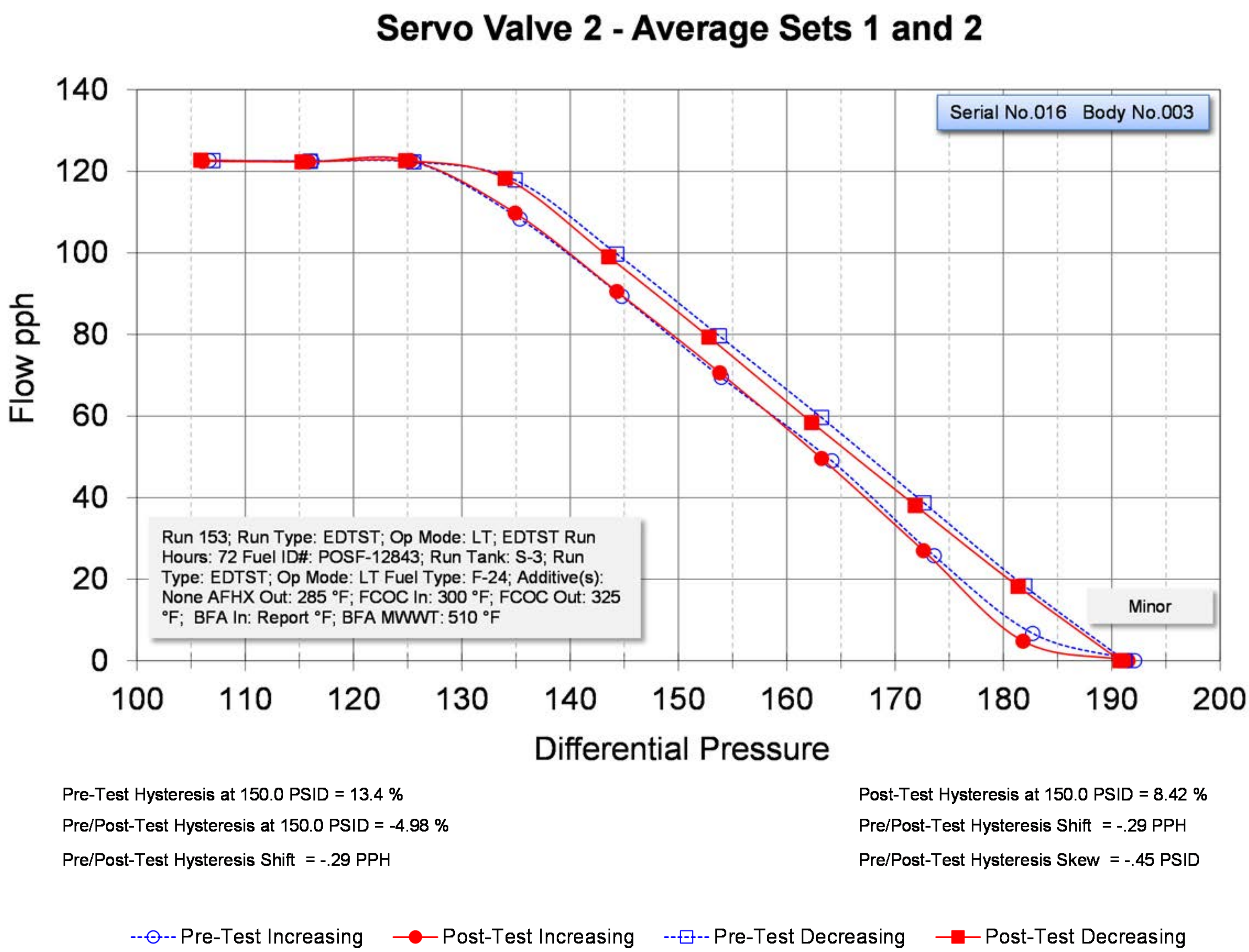


Figure I - 5 Servo Valve Hysteresis

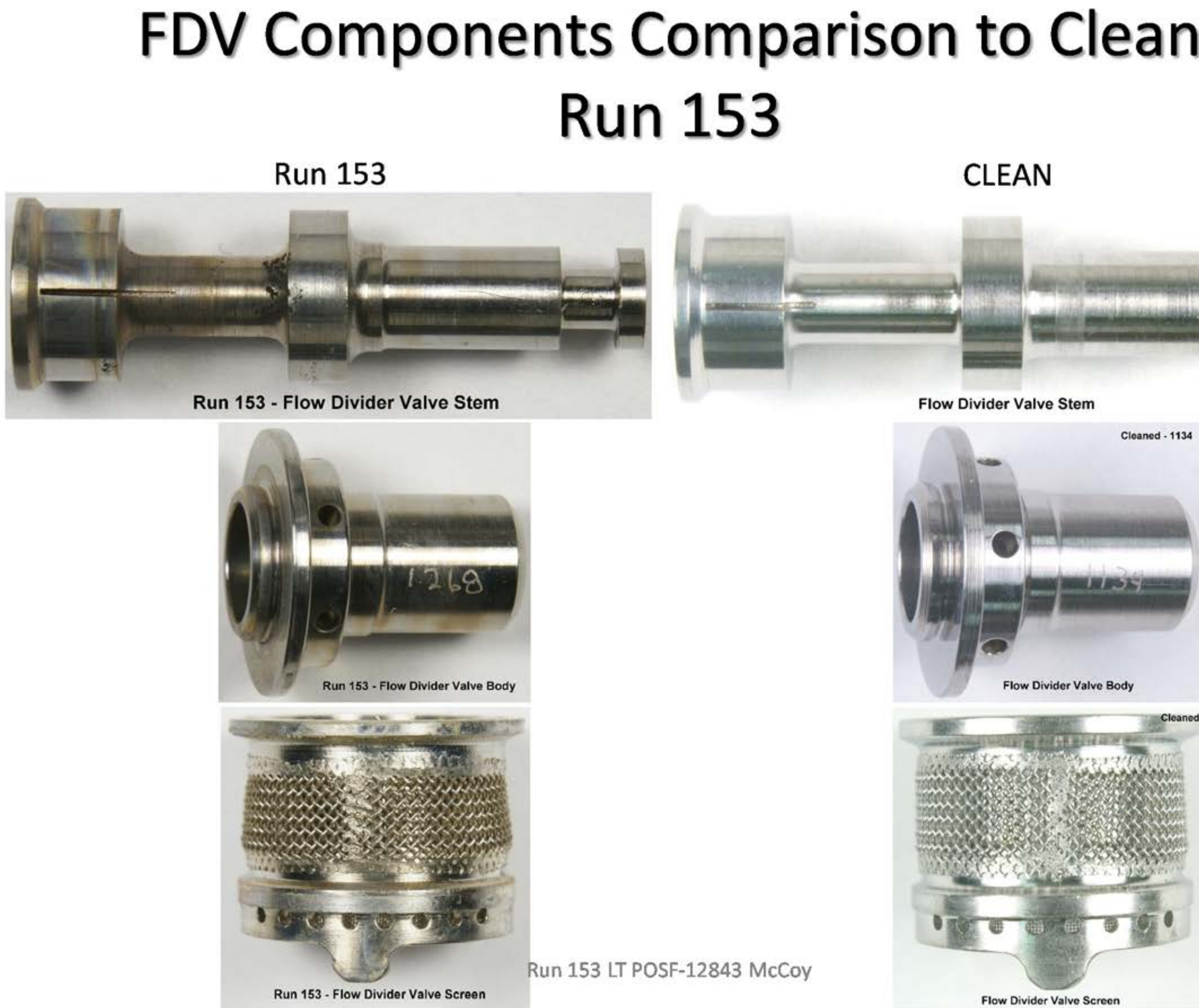


Figure I - 6 FDV Components - Comparison to Clean

Servo Valve and Nozzle Simulator Components – Run 153

Run 153 LT POSF-12843 McCoy

Figure I - 7 Servo Valve and Nozzle Screen Components - Comparison to Clean

TMS Screens Comparison to Clean - Run 153

Run 153

CLEAN

Figure I - 8 TMS Screen Top and Bottom - Comparison to Clean

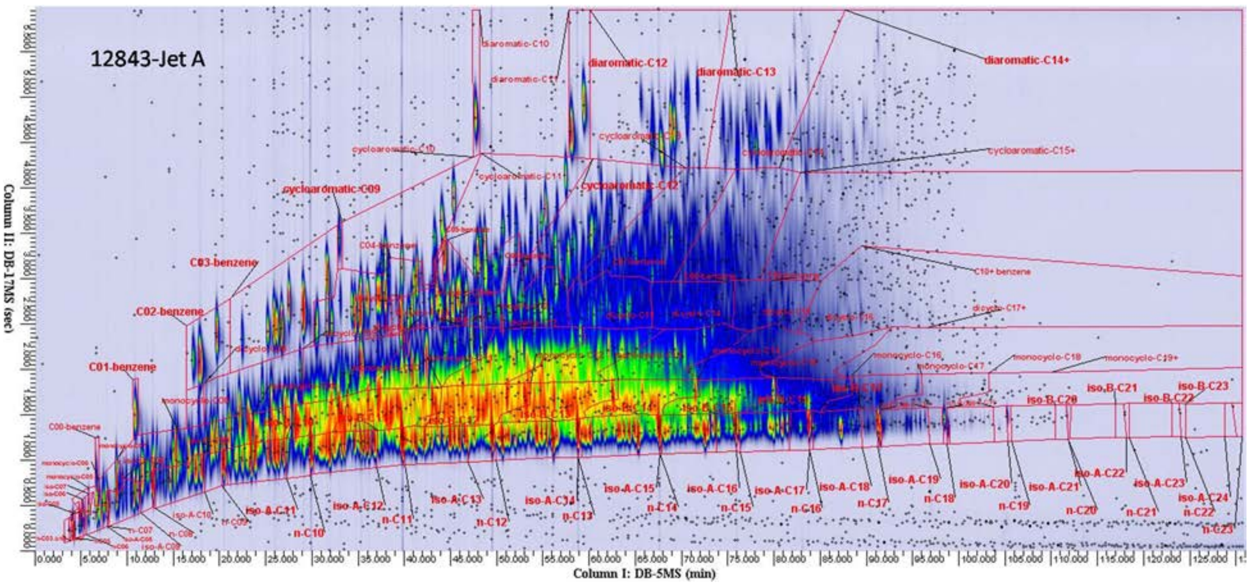


Figure I - 9 GCxGC Summary POSF-12843 Neat Fuel

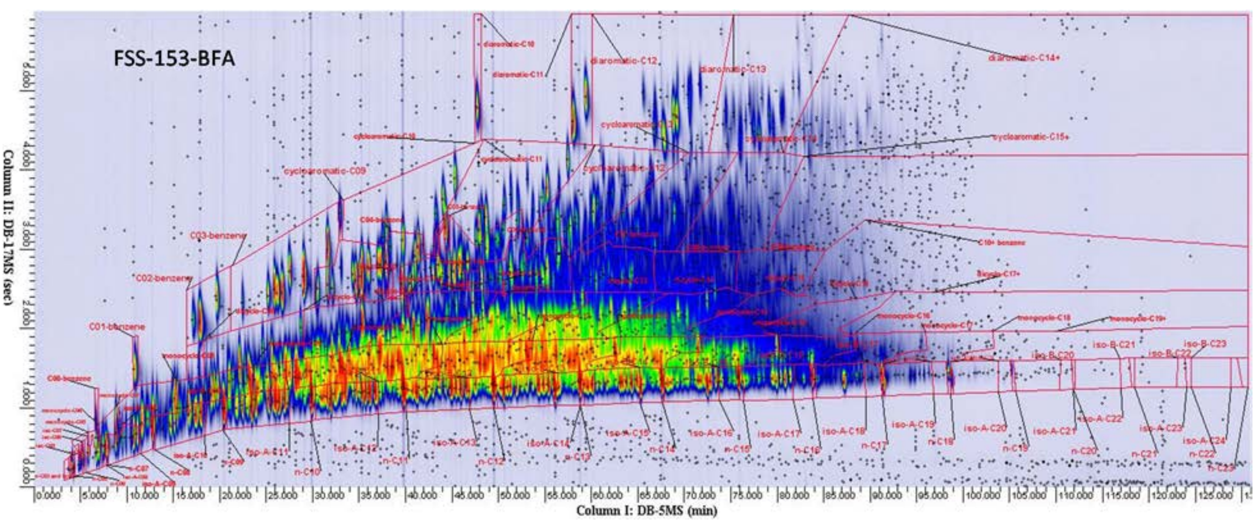


Figure I - 10 GCxGC Summary POSF-12843 Run 153 BFA Outlet

Table I - 1 GCxGC Tabulated Data POSF-12843 Jet A Neat and Run 153 BFA Outlet

GCxGC Summary				
Hydrogen content (weight %)	**13.9**		**13.9**	
Average Molecular Wt (g/mole)	**163**		**163**	
	POSF-12843- Jet A		**FSS153-BFA**	
	Weight %	**Volume %**	**Weight %**	**Volume %**
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	<0.01	<0.01
toluene (C07)	0.12	0.11	0.11	0.10
C2-benzene (C08)	0.56	0.52	0.55	0.51
C3-benzene (C09)	1.90	1.77	1.88	1.74
C4-benzene (C10)	2.45	2.29	2.43	2.26
C5-benzene (C11)	1.86	1.72	1.88	1.74
C6-benzene (C12)	1.62	1.51	1.62	1.51
C7-benzene (C13)	1.00	0.93	1.05	0.98
C8-benzene (C14)	0.83	0.77	0.77	0.72
C9-benzene (C15)	0.59	0.55	0.54	0.51
C10+-benzene (C16+)	0.40	0.37	0.39	0.36
Total Alkylbenzenes	**11.35**	10.56	**11.22**	10.44
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.10	0.08
diaromatic-C11	0.42	0.33	0.41	0.33
diaromatic-C12	0.73	0.58	0.72	0.58
diaromatic-C13	0.51	0.42	0.50	0.41
diaromatic-C14+	0.31	0.26	0.32	0.26
Total Alkylnaphthalenes	**2.08**	1.67	**2.05**	1.65
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.04	0.04	0.04	0.04
cycloaromatic-C10	0.37	0.30	0.36	0.30
cycloaromatic-C11	0.87	0.75	0.87	0.74
cycloaromatic-C12	1.16	1.01	1.21	1.05
cycloaromatic-C13	1.47	1.29	1.42	1.24
cycloaromatic-C14	0.83	0.73	0.87	0.76
cycloaromatics-C15+	0.41	0.36	0.40	0.35
Total Cycloaromatics	**5.16**	4.47	**5.17**	4.48
Total Aromatics	**18.59**	**16.70**	**18.45**	**16.56**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.22	0.27	0.21	0.26
C08-isoparaffins	0.44	0.50	0.43	0.49
C09-isoparaffins	0.84	0.94	0.84	0.95
C10-isoparaffins	3.27	3.60	3.25	3.59
C11-isoparaffins	4.25	4.59	4.37	4.72
C12-isoparaffins	3.56	3.85	3.60	3.90
C13-isoparaffins	3.40	3.59	3.43	3.63
C14-isoparaffins	3.18	3.34	3.18	3.33
C15-isoparaffins	2.29	2.39	2.35	2.45
C16-isoparaffins	1.06	1.10	1.06	1.10
C17-isoparaffins	0.56	0.58	0.53	0.55
C18-isoparaffins	0.15	0.15	0.16	0.16
C19-isoparaffins	0.08	0.08	0.08	0.08
C20-isoparaffins	0.03	0.03	0.03	0.03
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01
Total iso-Paraffins	**23.31**	25.01	**23.53**	25.23

n-Paraffins				
n-C07 & lower	0.17	0.20	0.18	0.21
n-C08	0.43	0.49	0.42	0.48
n-C09	1.01	1.13	1.00	1.11
n-C10	2.54	2.79	2.50	2.74
n-C11	3.01	3.26	3.00	3.24
n-C12	2.52	2.70	2.52	2.69
n-C13	2.00	2.12	2.01	2.13
n-C14	1.54	1.62	1.64	1.72
n-C15	0.89	0.93	0.88	0.92
n-C16	0.43	0.44	0.43	0.45
n-C17	0.20	0.20	0.20	0.20
n-C18	0.04	0.04	0.04	0.04
n-C19	<0.01	<0.01	<0.01	<0.01
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**14.80**	15.93	**14.82**	15.95
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.42	0.43	0.41	0.43
C08-monocyclocycloparaffins	0.63	0.64	0.61	0.62
C09-monocyclocycloparaffins	1.82	1.84	1.81	1.82
C10-monocyclocycloparaffins	4.60	4.50	4.60	4.50
C11-monocyclocycloparaffins	6.32	6.36	6.33	6.36
C12-monocyclocycloparaffins	5.57	5.57	5.43	5.43
C13-monocyclocycloparaffins	5.07	5.02	5.21	5.15
C14-monocyclocycloparaffins	3.15	3.12	3.16	3.13
C15-monocyclocycloparaffins	2.10	2.07	1.98	1.96
C16-monocyclocycloparaffins	0.86	0.85	0.92	0.90
C17-monocyclocycloparaffins	0.33	0.32	0.39	0.38
C18-monocyclocycloparaffins	0.05	0.05	0.05	0.05
C19+-monocyclocycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Monocycloparaffins	**30.93**	30.78	**30.91**	30.75
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.45	0.42	0.44	0.40
C10-dicycloparaffins	1.01	0.90	1.04	0.93
C11-dicycloparaffins	2.32	2.17	2.19	2.05
C12-dicycloparaffins	2.69	2.54	2.57	2.43
C13-dicycloparaffins	3.00	2.83	3.38	3.18
C14-dicycloparaffins	1.94	1.83	1.72	1.62
C15-dicycloparaffins	0.60	0.56	0.62	0.59
C16-dicycloparaffins	0.21	0.20	0.19	0.17
C17+-dicycloparaffins	0.04	0.03	0.02	0.02
Total Dicycloparaffins	**12.27**	11.51	**12.19**	11.43
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.09	0.07	0.09	0.08
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.09**	0.08	**0.10**	0.08
Total Cycloparaffins	**43.29**	42.36	**43.20**	42.26
Average Molecular Formula - C	11.7		11.7	
Average Molecular Formula - H	22.4		22.4	

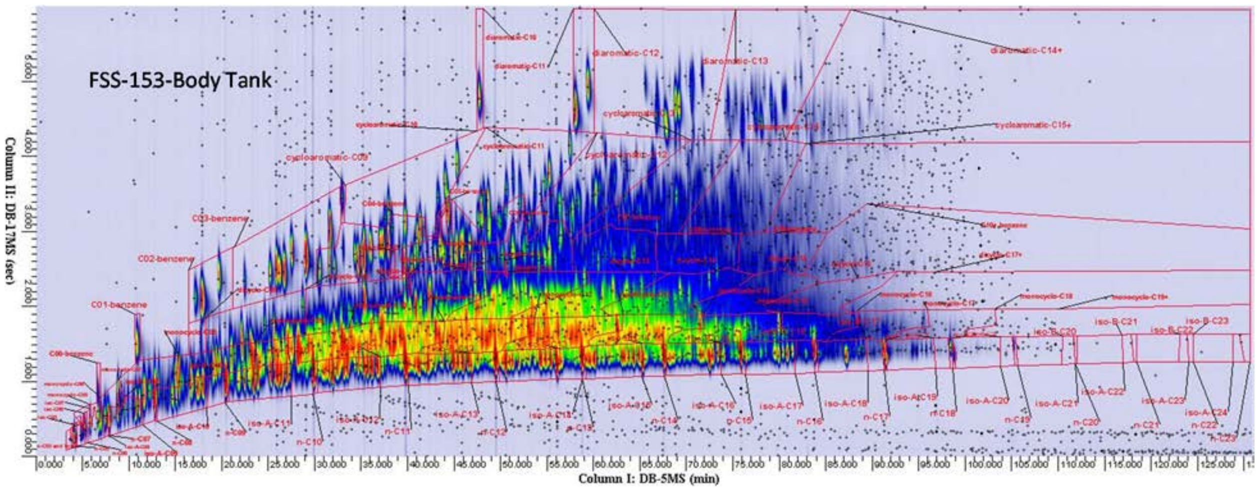


Figure I - 11 GCxGC Summary Fuel From Body Tank

Table I - 2 GCxGC Tabulated Data - Fuel From Body Tank at the End Of Run

GCxGC Summary				
Hydrogen content (weight %)	13.9		13.9	
Average Molecular Wt (g/mole)	163		163	
	POSF-12843- Jet A		**FSS153-Body Tank**	
	Weight %	**Volume %**	**Weight %**	**Volume %**
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	<0.01	<0.01
toluene (C07)	0.12	0.11	0.11	0.10
C2-benzene (C08)	0.56	0.52	0.55	0.51
C3-benzene (C09)	1.90	1.77	1.88	1.74
C4-benzene (C10)	2.45	2.29	2.43	2.26
C5-benzene (C11)	1.86	1.72	1.88	1.74
C6-benzene (C12)	1.62	1.51	1.59	1.48
C7-benzene (C13)	1.00	0.93	0.99	0.92
C8-benzene (C14)	0.83	0.77	0.83	0.77
C9-benzene (C15)	0.59	0.55	0.62	0.58
C10+-benzene (C16+)	0.40	0.37	0.37	0.35
Total Alkylbenzenes	**11.35**	10.56	**11.26**	10.47
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.10	0.08
diaromatic-C11	0.42	0.33	0.41	0.33
diaromatic-C12	0.73	0.58	0.71	0.57
diaromatic-C13	0.51	0.42	0.51	0.41
diaromatic-C14+	0.31	0.26	0.30	0.25
Total Alkylnaphthalenes	**2.08**	1.67	**2.03**	1.63
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.04	0.04	0.04	0.04
cycloaromatic-C10	0.37	0.30	0.37	0.30
cycloaromatic-C11	0.87	0.75	0.86	0.74
cycloaromatic-C12	1.16	1.01	1.25	1.09
cycloaromatic-C13	1.47	1.29	1.43	1.25
cycloaromatic-C14	0.83	0.73	0.84	0.73
cycloaromatics-C15+	0.41	0.36	0.43	0.37
Total Cycloaromatics	**5.16**	4.47	**5.22**	4.52
Total Aromatics	**18.59**	**16.70**	**18.51**	**16.62**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.22	0.27	0.21	0.26
C08-isoparaffins	0.44	0.50	0.43	0.49
C09-isoparaffins	0.84	0.94	0.83	0.93
C10-isoparaffins	3.27	3.60	3.31	3.65
C11-isoparaffins	4.25	4.59	4.26	4.60
C12-isoparaffins	3.56	3.85	3.61	3.90
C13-isoparaffins	3.40	3.59	3.38	3.58
C14-isoparaffins	3.18	3.34	3.17	3.33
C15-isoparaffins	2.29	2.39	2.35	2.45
C16-isoparaffins	1.06	1.10	1.07	1.10
C17-isoparaffins	0.56	0.58	0.52	0.54
C18-isoparaffins	0.15	0.15	0.15	0.16
C19-isoparaffins	0.08	0.08	0.08	0.09
C20-isoparaffins	0.03	0.03	0.03	0.03
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01
Total iso-Paraffins	**23.31**	25.01	**23.41**	25.11

n-Paraffins				
n-C07 & lower	0.17	0.20	0.16	0.19
n-C08	0.43	0.49	0.42	0.48
n-C09	1.01	1.13	1.00	1.11
n-C10	2.54	2.79	2.52	2.77
n-C11	3.01	3.26	3.00	3.25
n-C12	2.52	2.70	2.55	2.72
n-C13	2.00	2.12	2.01	2.13
n-C14	1.54	1.62	1.54	1.61
n-C15	0.89	0.93	0.91	0.95
n-C16	0.43	0.44	0.42	0.44
n-C17	0.20	0.20	0.19	0.20
n-C18	0.04	0.04	0.04	0.04
n-C19	<0.01	<0.01	<0.01	<0.01
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**14.80**	15.93	**14.79**	15.92
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.42	0.43	0.41	0.43
C08-monocyclocycloparaffins	0.63	0.64	0.63	0.64
C09-monocyclocycloparaffins	1.82	1.84	1.76	1.78
C10-monocyclocycloparaffins	4.60	4.50	4.57	4.47
C11-monocyclocycloparaffins	6.32	6.36	6.40	6.43
C12-monocyclocycloparaffins	5.57	5.57	5.46	5.46
C13-monocyclocycloparaffins	5.07	5.02	5.14	5.08
C14-monocyclocycloparaffins	3.15	3.12	3.18	3.15
C15-monocyclocycloparaffins	2.10	2.07	2.01	1.99
C16-monocyclocycloparaffins	0.86	0.85	0.90	0.88
C17-monocyclocycloparaffins	0.33	0.32	0.40	0.39
C18-monocyclocycloparaffins	0.05	0.05	0.05	0.05
C19+-monocyclocycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Monocycloparaffins	**30.93**	30.78	**30.91**	30.76
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.45	0.42	0.46	0.42
C10-dicycloparaffins	1.01	0.90	1.10	0.98
C11-dicycloparaffins	2.32	2.17	2.21	2.08
C12-dicycloparaffins	2.69	2.54	2.65	2.50
C13-dicycloparaffins	3.00	2.83	3.09	2.91
C14-dicycloparaffins	1.94	1.83	1.96	1.85
C15-dicycloparaffins	0.60	0.56	0.55	0.52
C16-dicycloparaffins	0.21	0.20	0.20	0.19
C17+-dicycloparaffins	0.04	0.03	0.03	0.02
Total Dicycloparaffins	**12.27**	11.51	**12.28**	11.51
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.09	0.07	0.09	0.08
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.09**	0.08	**0.10**	0.08
Total Cycloparaffins	**43.29**	42.36	**43.29**	42.35
Average Molecular Formula - C	11.7		11.7	
Average Molecular Formula - H	22.4		22.4	

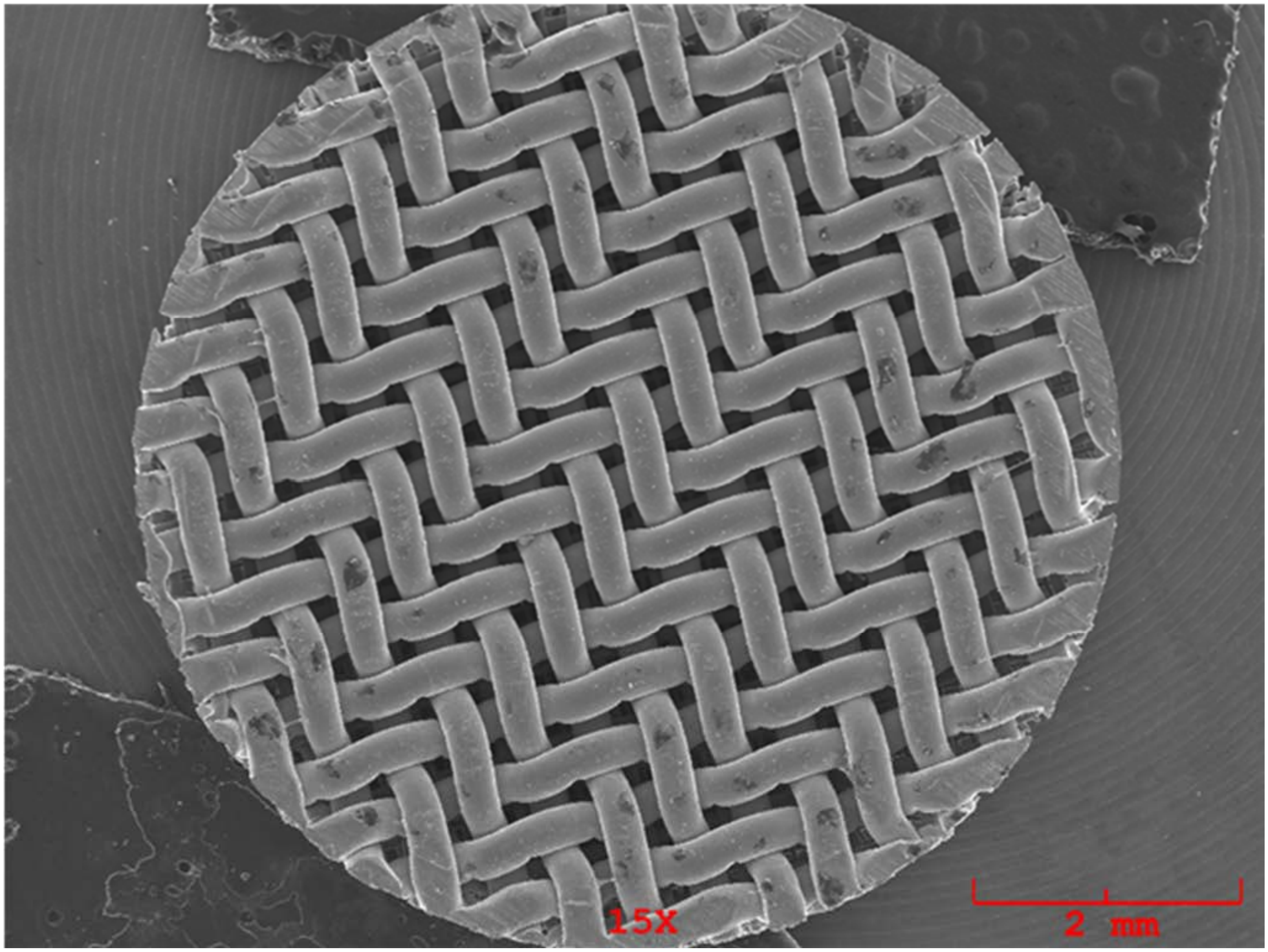
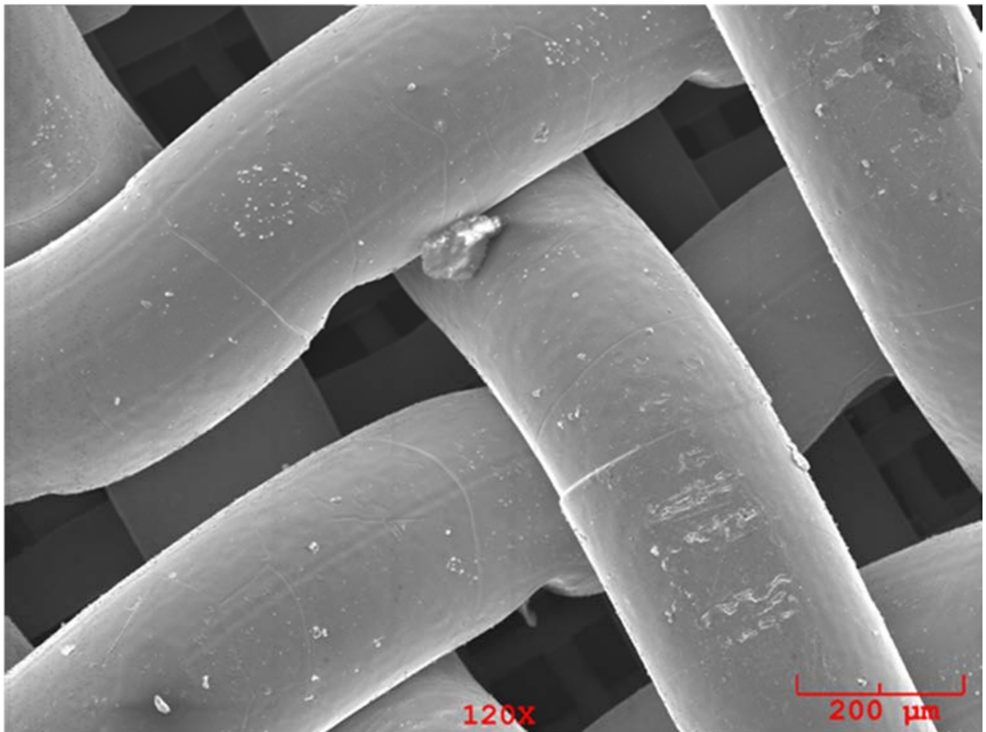


Figure I - 12 TMS Screen, Top, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	6.58	2.470	wt.%	0.307	0.365	
O	Ka	3.63	0.489	wt.%	0.095	0.123	
Al	Ka	6.82	0.654	wt.%	0.103	0.138	
Si	Ka	3.54	0.273	wt.%	0.083	0.119	
S	Ka	7.98	0.481	wt.%	0.074	0.100	
Cr	Ka	213.22	17.770	wt.%	0.259	0.134	
Fe	Ka	497.59	68.856	wt.%	0.633	0.214	
Ni	Ka	43.55	9.008	wt.%	0.323	0.265	
			100.000	wt.%			Total

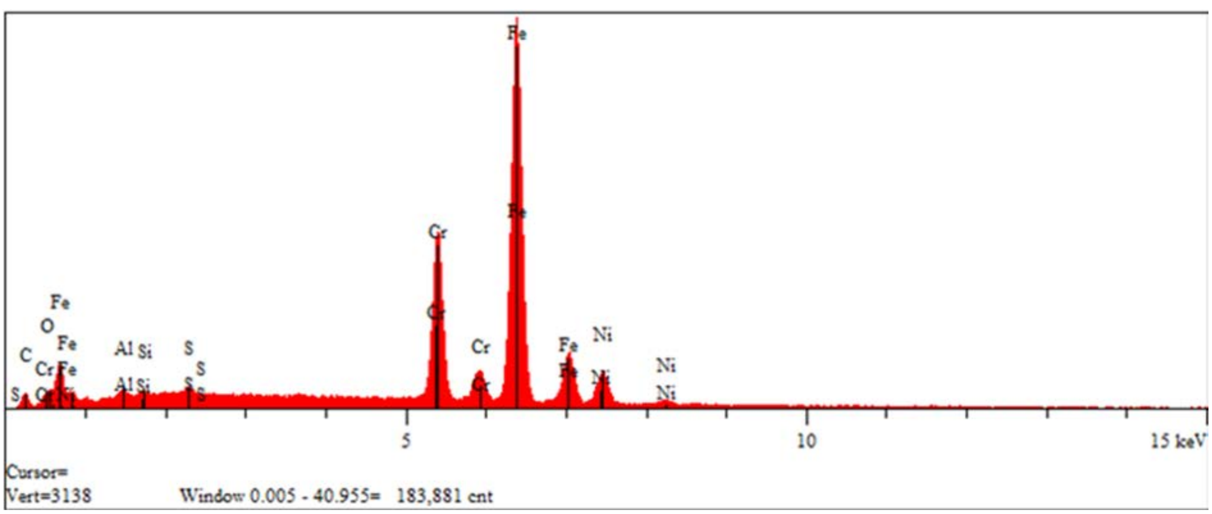


Figure I - 13 TMS Screen Top, 120X and EDX Elemental Analysis

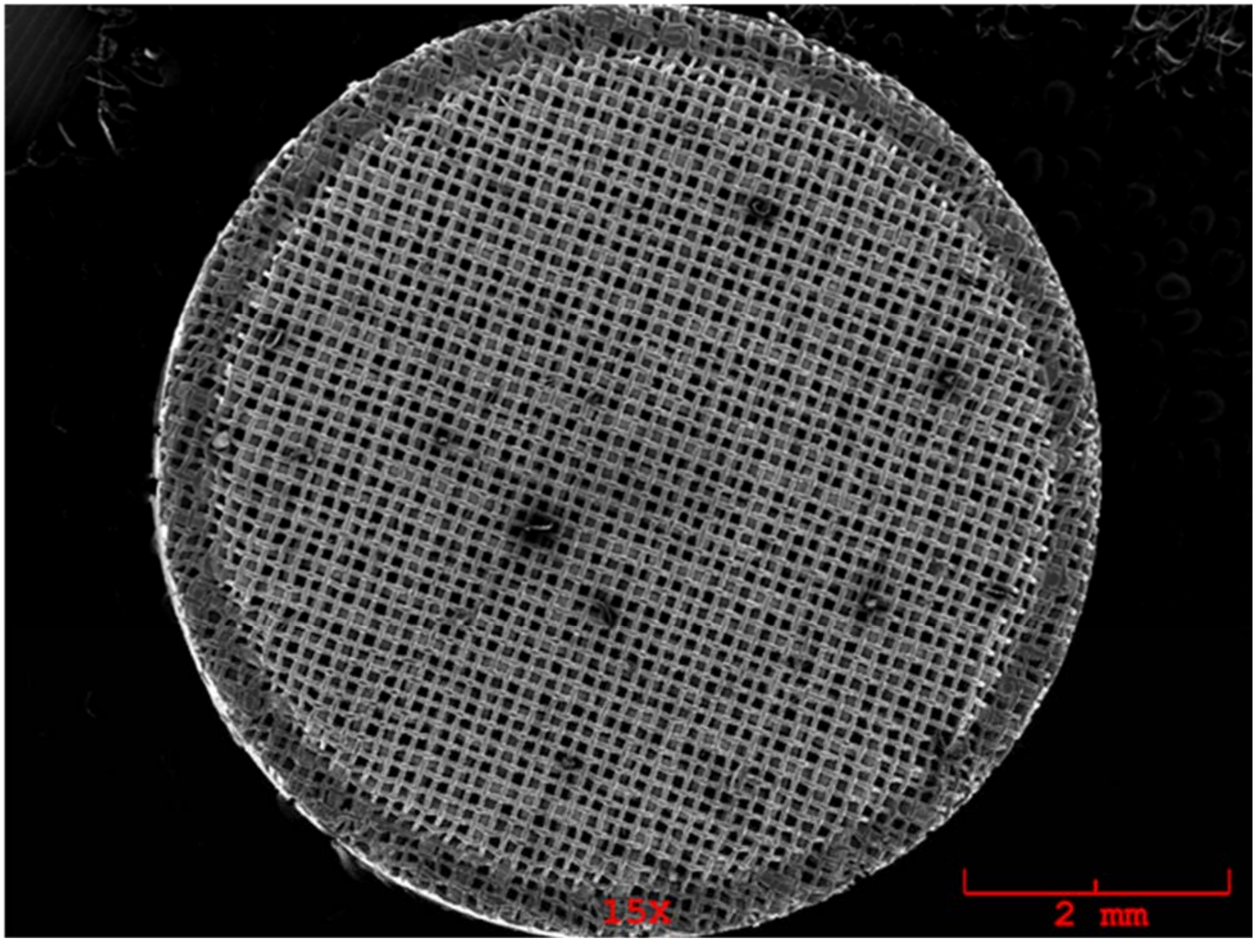
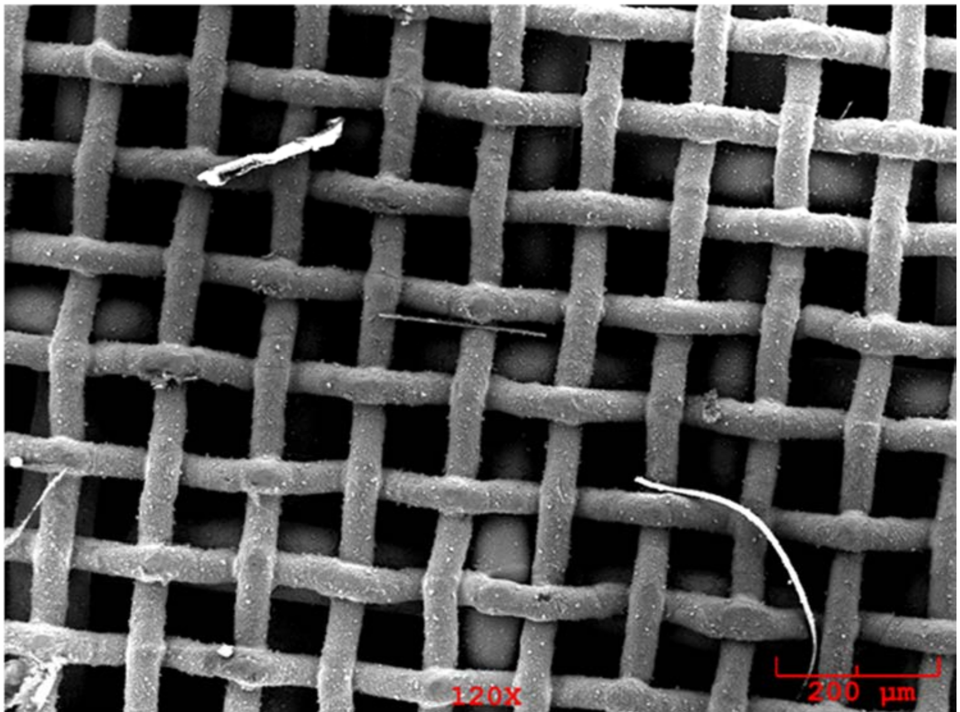


Figure I - 14 TMS Screen, Bottom, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	28.17	12.734	wt.%	0.522	0.316	
O	Ka	12.39	2.452	wt.%	0.165	0.136	
Al	Ka	7.70	0.810	wt.%	0.108	0.140	
Si	Ka	4.28	0.367	wt.%	0.088	0.123	
S	Ka	43.44	2.984	wt.%	0.113	0.103	
Cr	Ka	149.05	15.040	wt.%	0.263	0.143	
Fe	Ka	340.38	55.306	wt.%	0.616	0.220	
Ni	Ka	26.22	6.256	wt.%	0.295	0.253	
Zn	Ka	11.25	4.051	wt.%	0.332	0.349	
			100.000	wt.%			Total

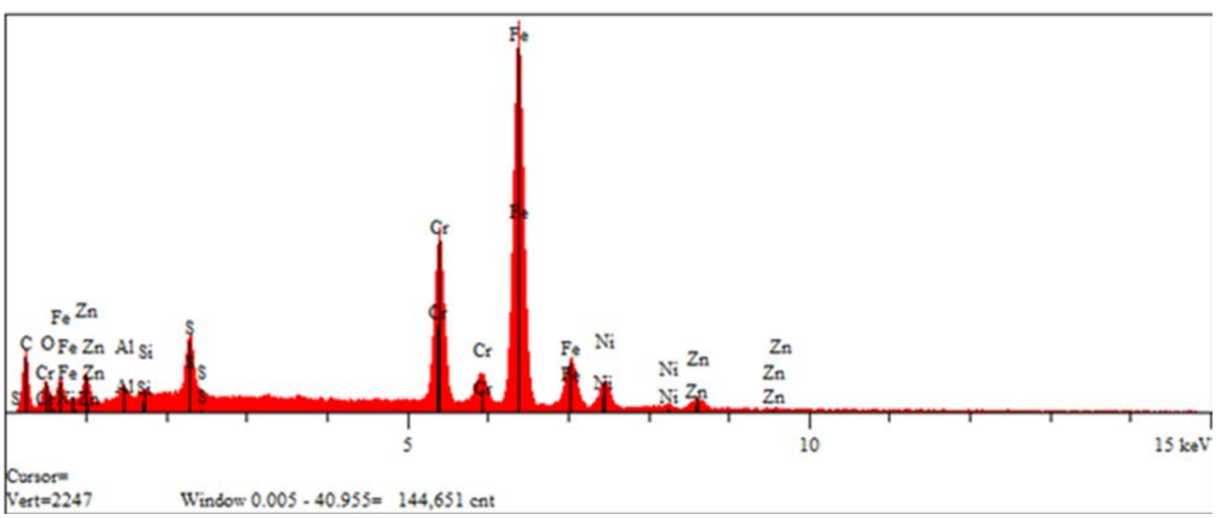


Figure I- 15 TMS Screen, Bottom, 120X and EDX Elemental Analysis

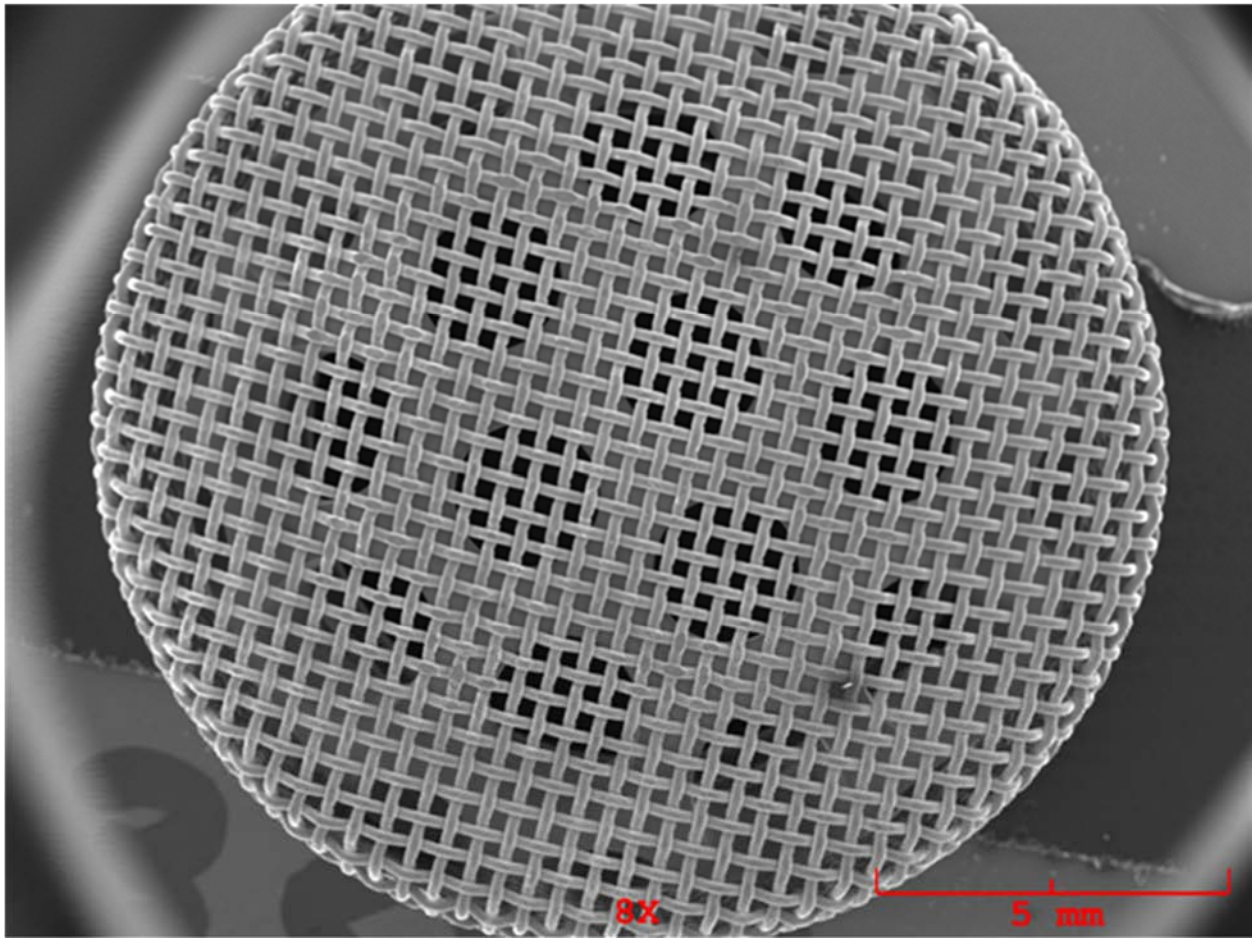
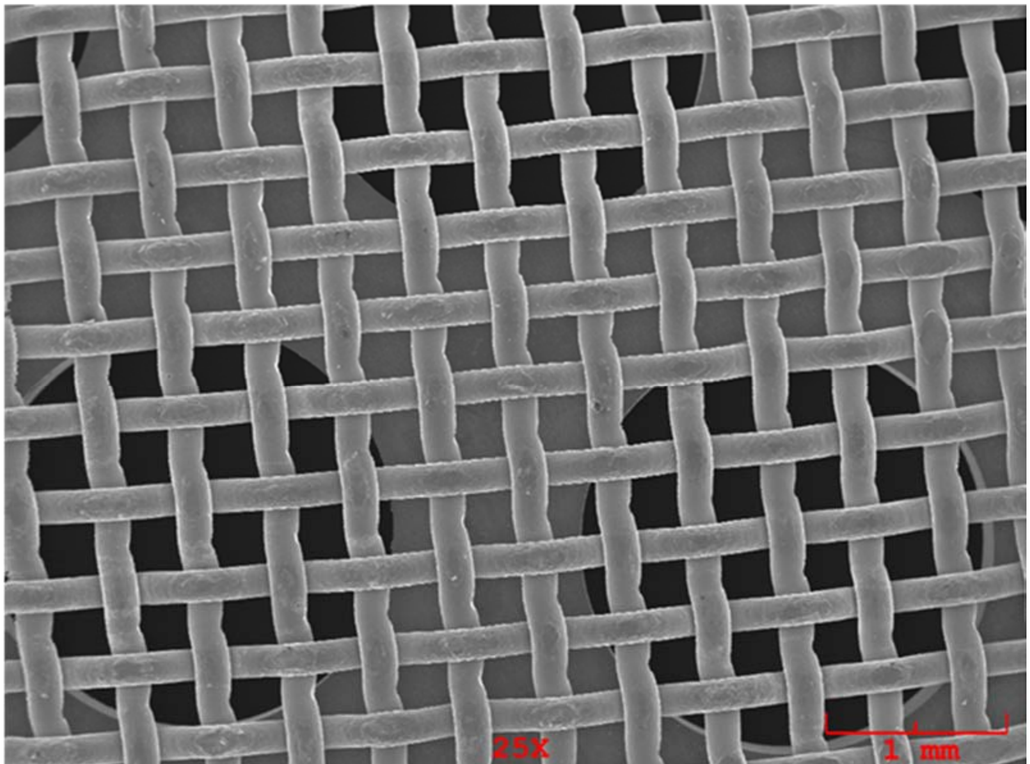


Figure I - 16 F303 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	5.34	2.862	wt.%	0.398	0.476	
Al	Ka	1.51	0.201	wt.%	0.112	0.164	
Si	Ka	5.83	0.621	wt.%	0.106	0.142	
S	Ka	13.88	1.163	wt.%	0.102	0.123	
Cr	Ka	146.76	16.967	wt.%	0.296	0.147	
Fe	Ka	356.20	68.246	wt.%	0.741	0.249	
Ni	Ka	34.67	9.941	wt.%	0.394	0.312	
			100.000	wt.%			Total

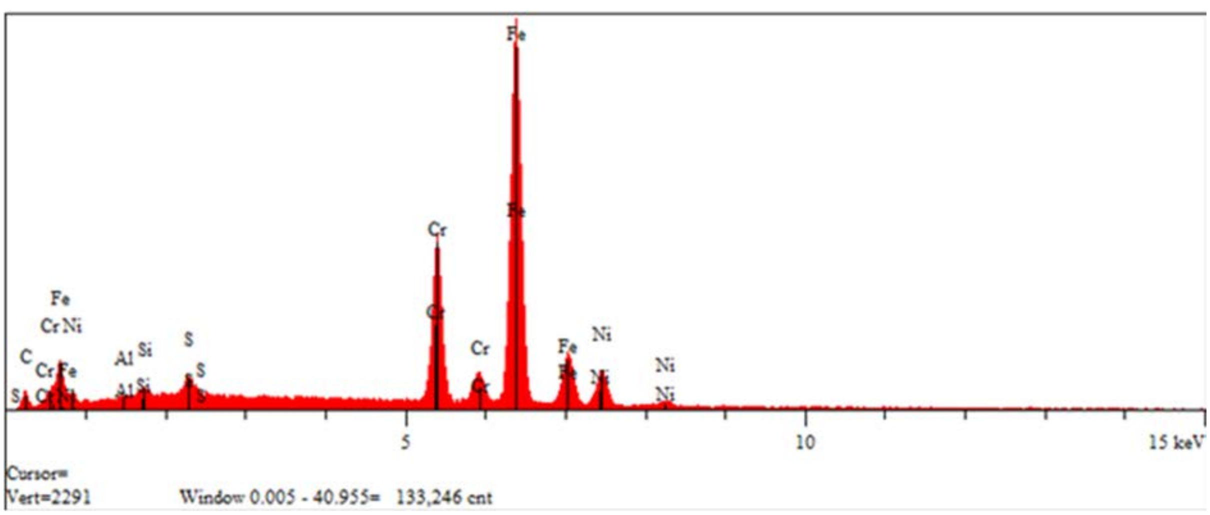


Figure I - 17 F303 Bottom 25X and EDX Elemental Analysis

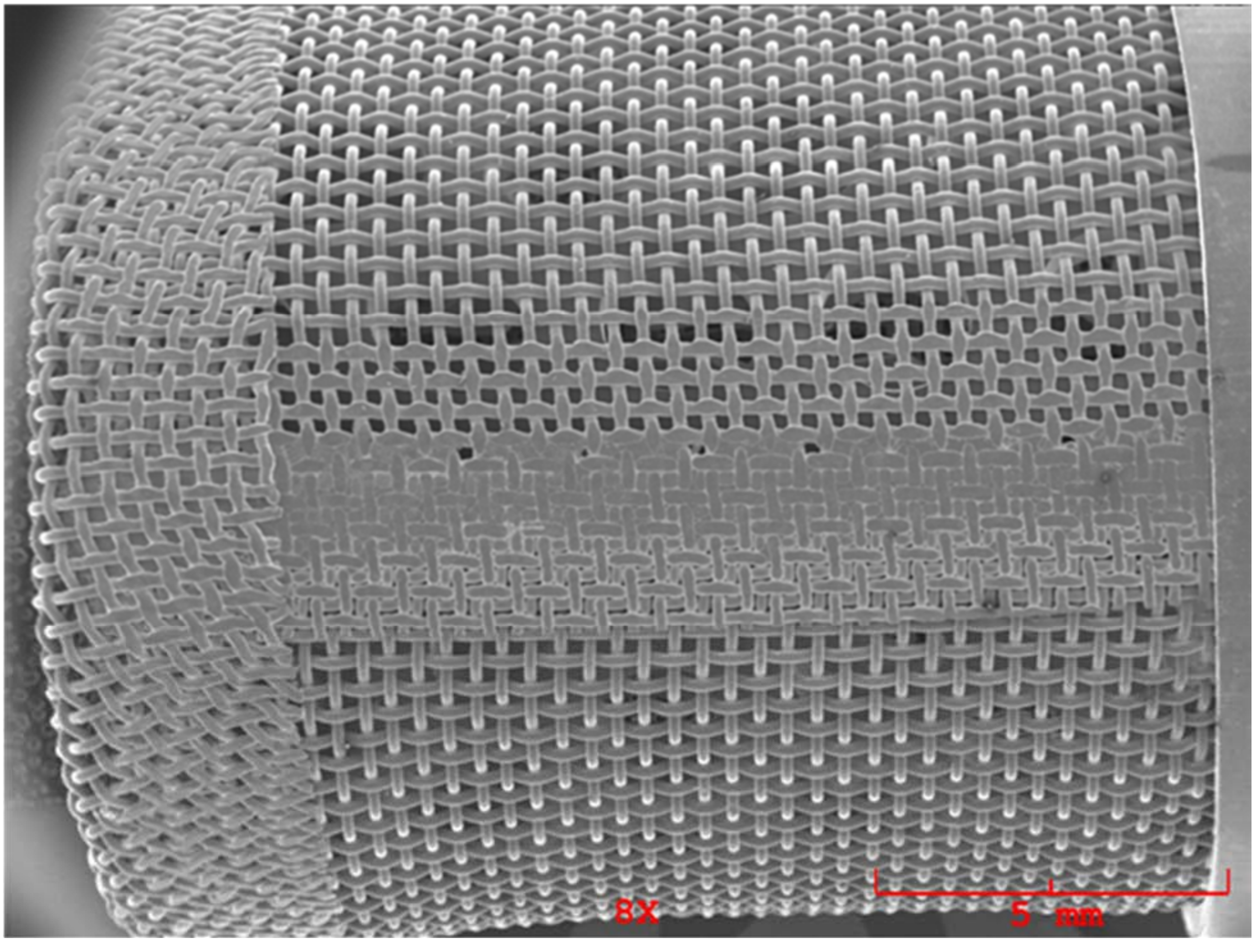
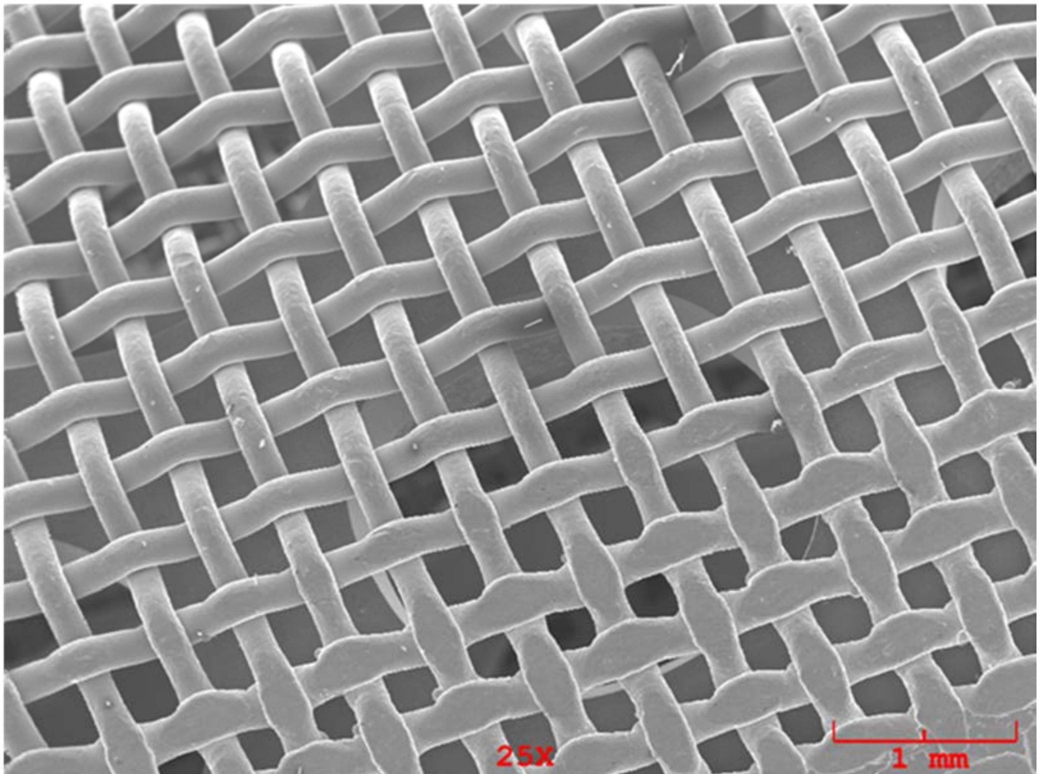


Figure I - 18 F303 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	3.89	1.928	wt.%	0.370	0.481	
Al	Ka	1.95	0.240	wt.%	0.109	0.158	
Si	Ka	6.33	0.622	wt.%	0.101	0.135	
S	Ka	14.33	1.106	wt.%	0.095	0.115	
Cr	Ka	160.21	16.975	wt.%	0.284	0.145	
Fe	Ka	392.98	69.128	wt.%	0.716	0.246	
Ni	Ka	37.95	10.000	wt.%	0.382	0.309	
			100.000	wt.%			Total

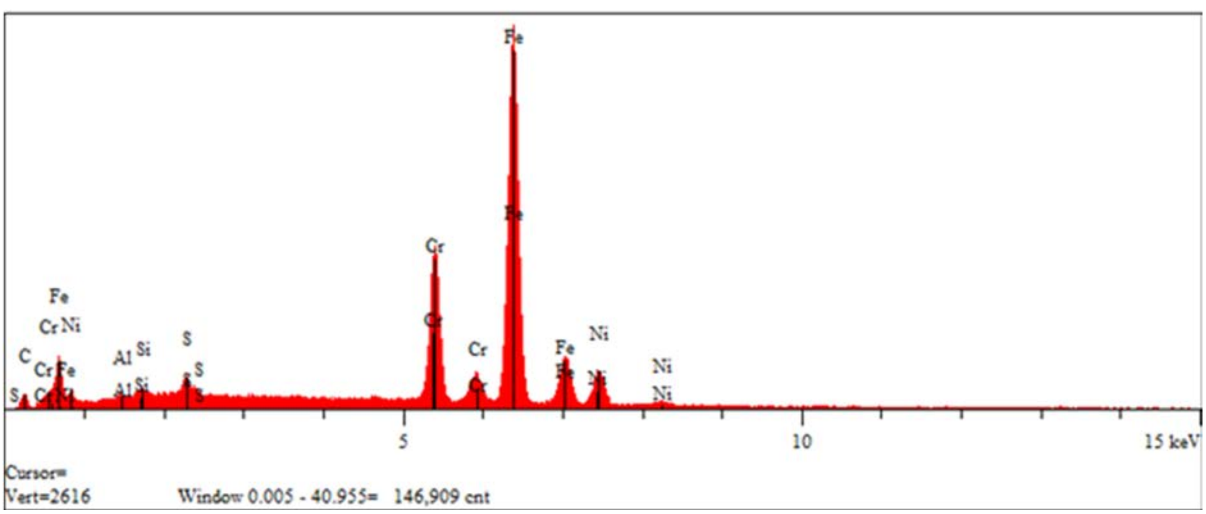


Figure I - 19 F303 Side 25X and EDX Elemental Analysis

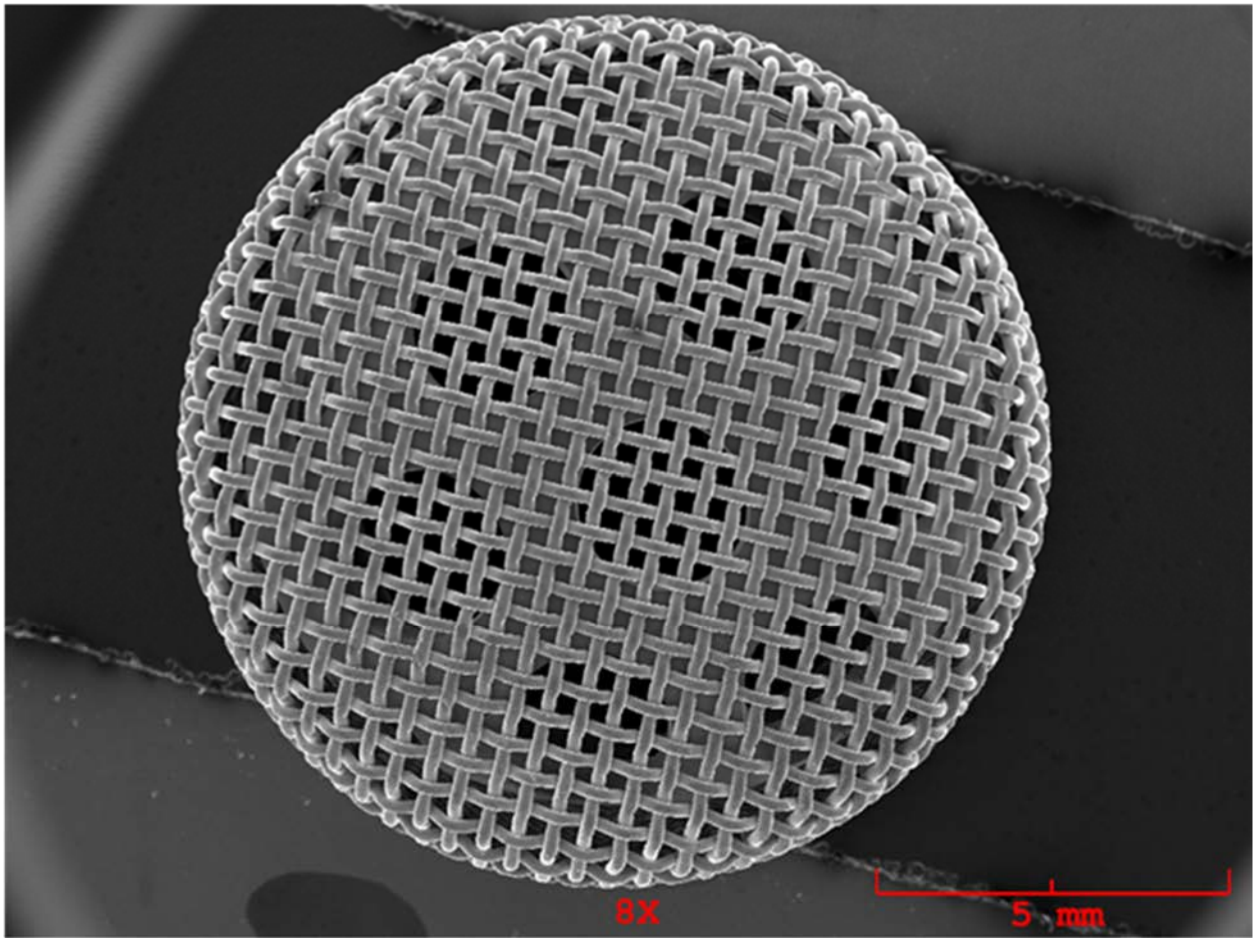
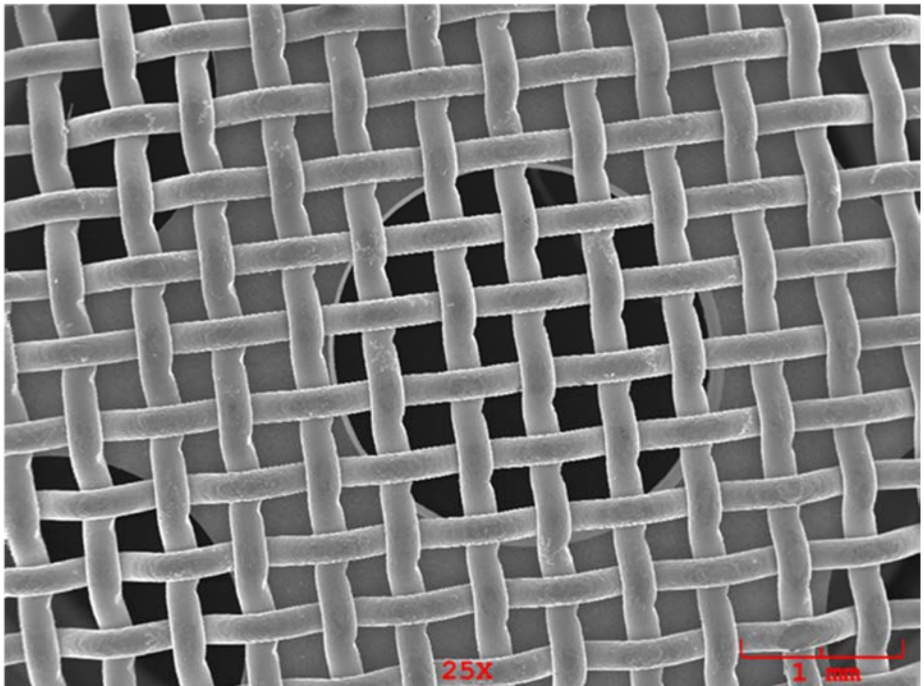


Figure I - 20 F304 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	3.38	1.931	wt.%	0.416	0.550	
Al	Ka	1.08	0.153	wt.%	0.118	0.175	
Si	Ka	3.92	0.444	wt.%	0.108	0.150	
S	Ka	14.00	1.243	wt.%	0.106	0.127	
Cr	Ka	136.57	16.608	wt.%	0.303	0.162	
Fe	Ka	344.33	69.736	wt.%	0.772	0.271	
Ni	Ka	32.56	9.885	wt.%	0.406	0.325	
			100.000	wt.%			Total

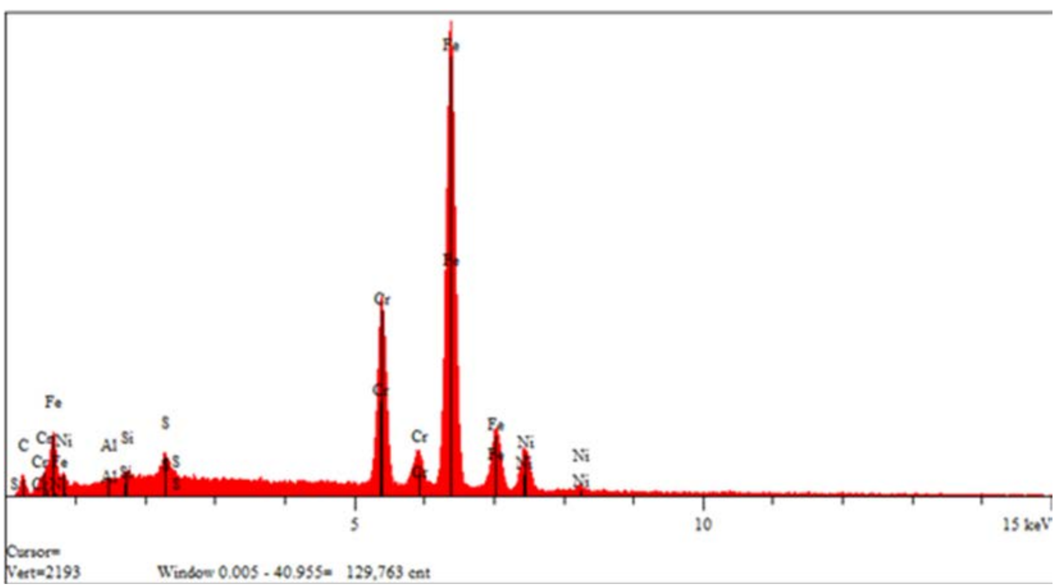


Figure I - 21 F304 Bottom, 25X and EDX Elemental Analysis

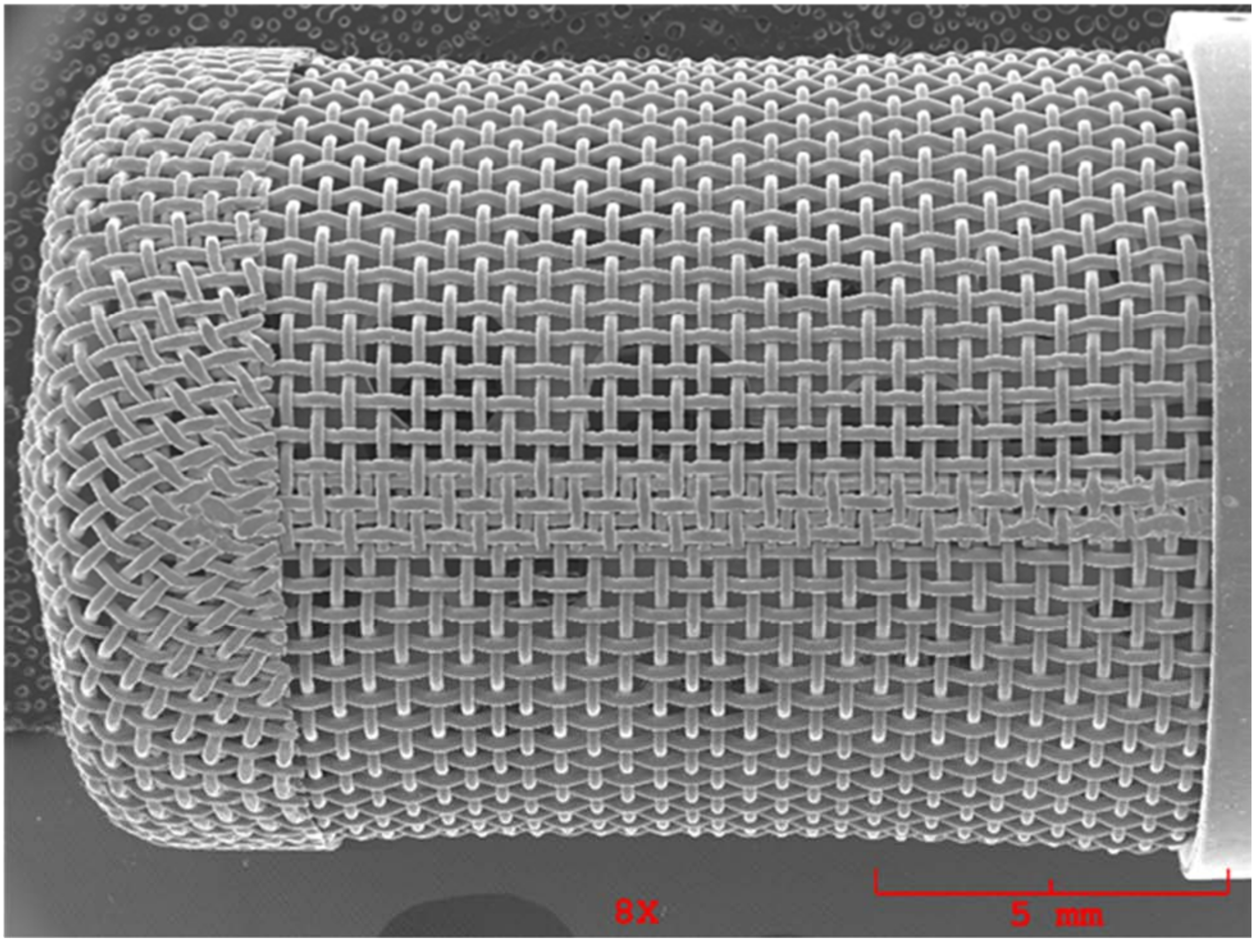
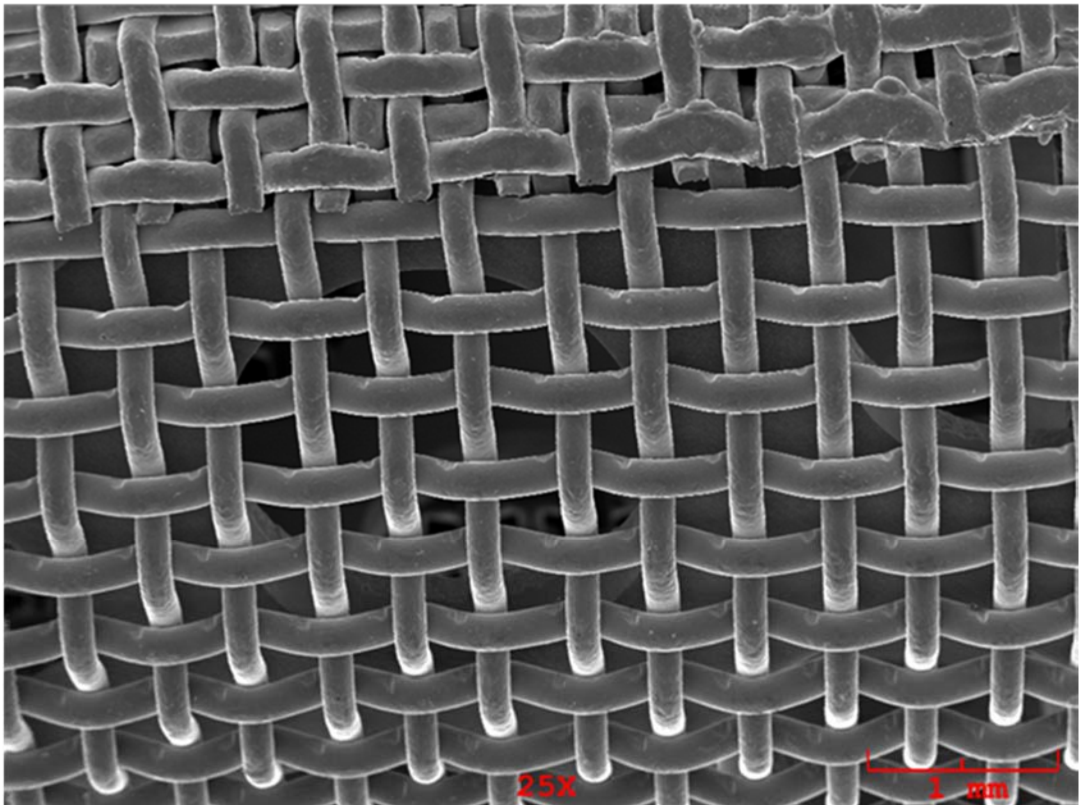


Figure I - 22 F304 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	3.99	2.413	wt.%	0.376	0.442	
Al	Ka	2.47	0.369	wt.%	0.126	0.178	
Si	Ka	3.91	0.470	wt.%	0.111	0.153	
S	Ka	12.80	1.206	wt.%	0.108	0.129	
Cr	Ka	130.28	16.881	wt.%	0.316	0.169	
Fe	Ka	321.46	69.240	wt.%	0.793	0.276	
Ni	Ka	29.21	9.421	wt.%	0.414	0.343	
			100.000	wt.%			Total

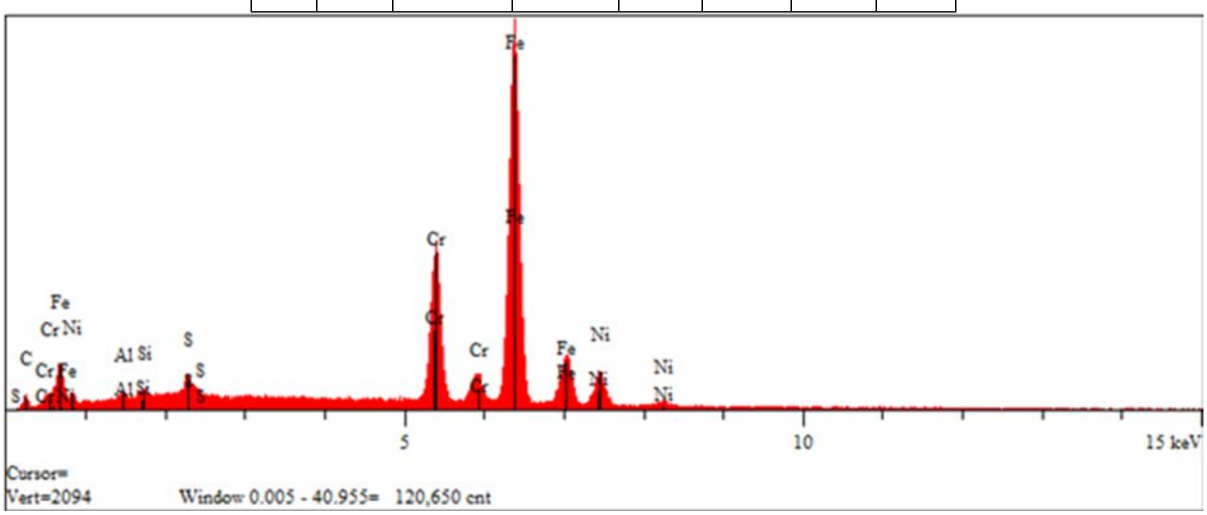


Figure I - 23 F304 Side, 25X and EDX Elemental Analysis

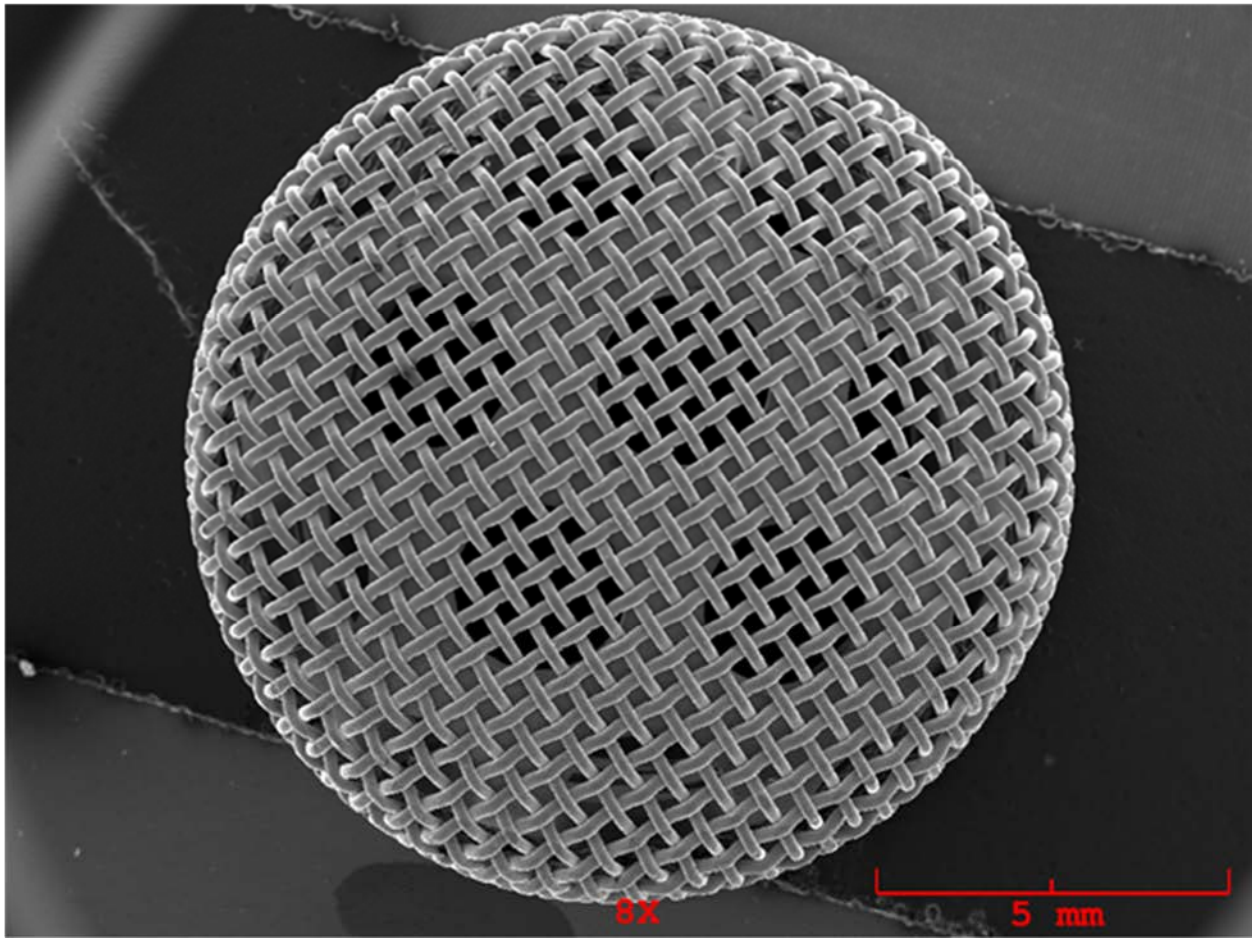
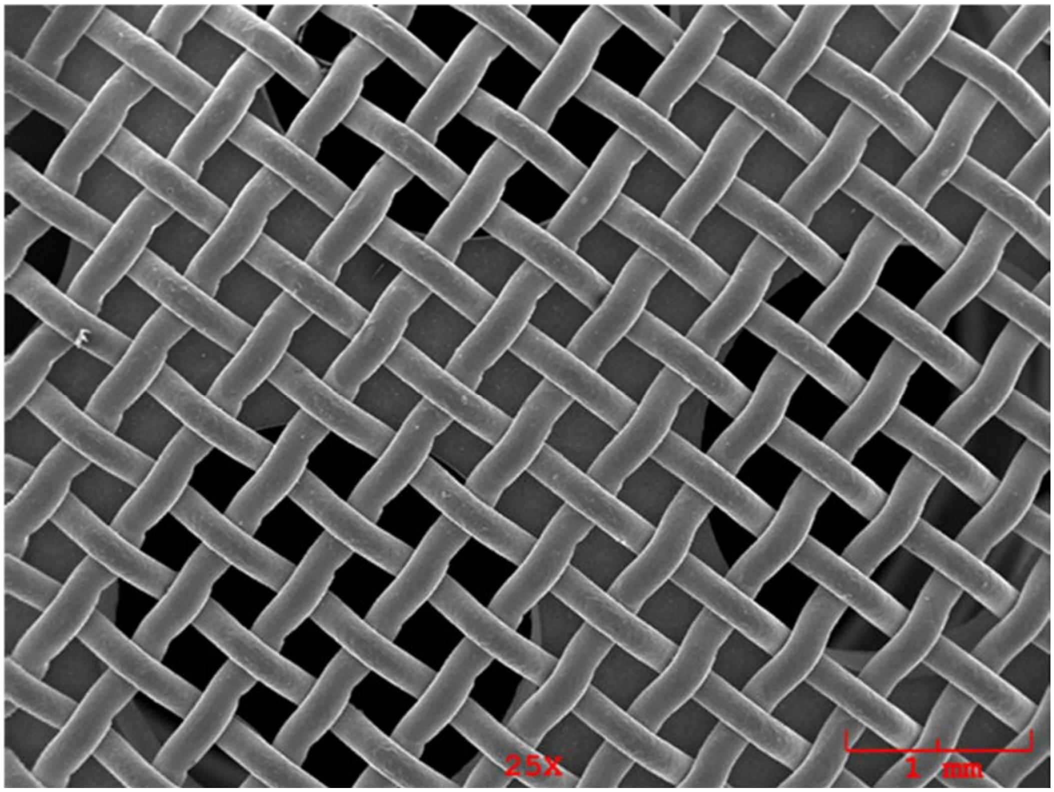


Figure I - 24 F702 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	3.54	1.917	wt.%	0.328	0.394	
Al	Ka	2.95	0.393	wt.%	0.117	0.164	
Si	Ka	5.56	0.595	wt.%	0.106	0.143	
S	Ka	13.96	1.173	wt.%	0.103	0.125	
Cr	Ka	144.37	16.600	wt.%	0.293	0.151	
Fe	Ka	363.59	69.571	wt.%	0.748	0.251	
Ni	Ka	34.01	9.751	wt.%	0.397	0.327	
			100.000	wt.%			Total

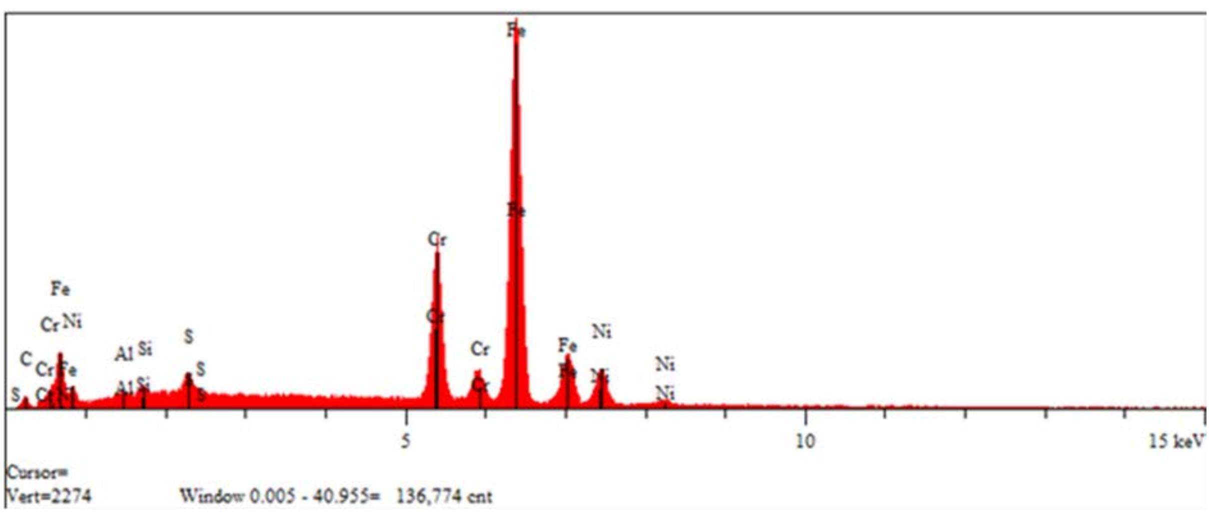


Figure I - 25 F702 Bottom, 25X and EDX Elemental Analysis

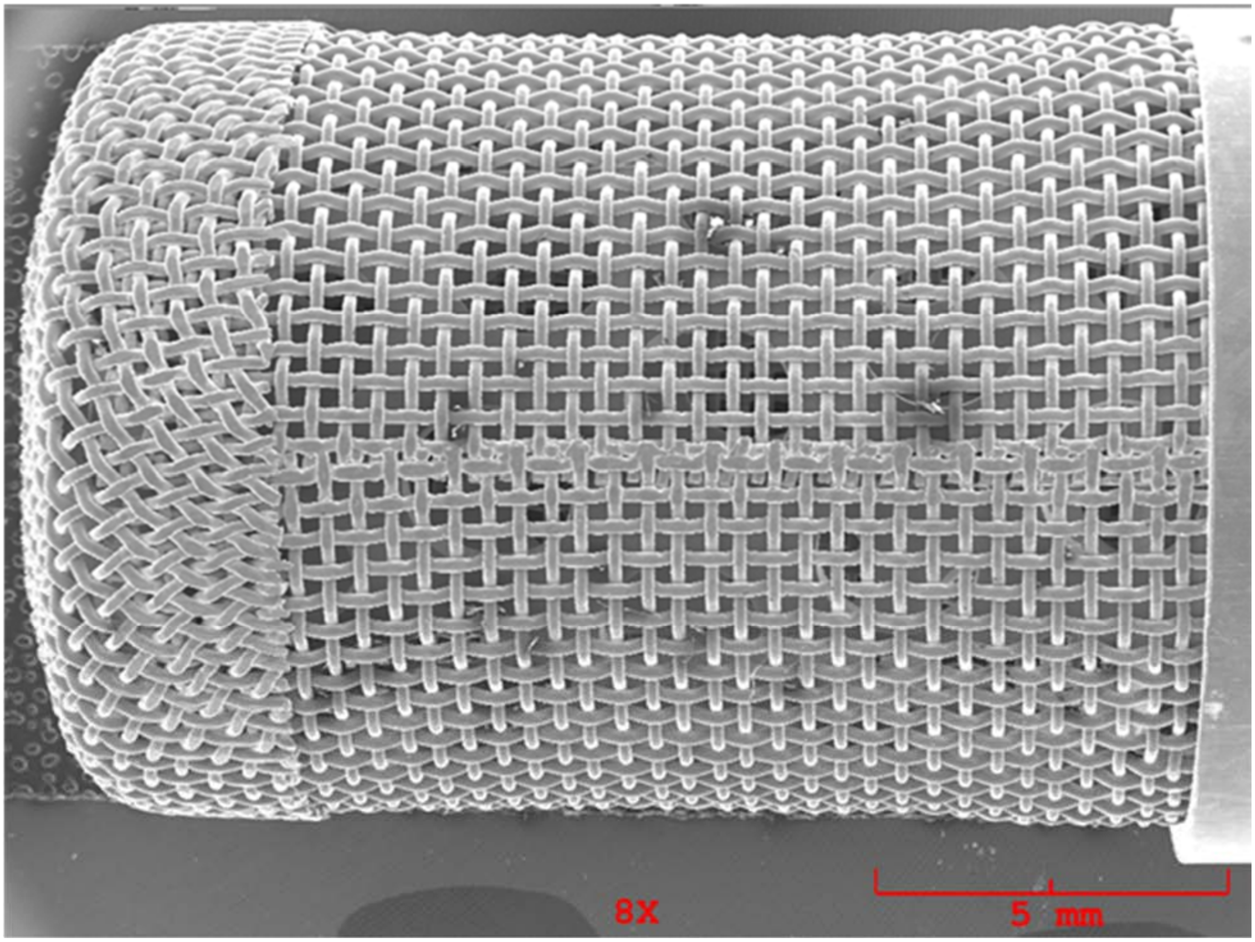


Figure I - 26 F702 Side, 8X

APPENDIX J - RUN 154 DATA PACKAGE

Run Conditions: EDTST Mode, MT Conditions
Fuel ID: POSF-12843, Ft McCoy
Airframe Heat Exchanger Bulk Fuel Output: 285 °F
HP Pump HX Out/FCOC Bulk Fuel In: 325 °F
Fuel-Cooled Oil Cooler Bulk Fuel Output: 350 °F
Burner Feed Arm Max Wetted Wall Temperature: 510 °F
Run Duration: 72 Hours

DATA SUMMARY

Run 154; Run Type: EDTST; Op Mode: MT; EDTST Run Hours: 72 Fuel ID#: POSF-12843; Run Tank: S-3; Run Type: EDTST; Op Mode: MT Fuel Type: F-24; Additive(s): None AFHX Out: 285 °F; FCOC In: 325 °F; FCOC Out: 350 °F; BFA In: Report °F; BFA MWWT: 510 °F;

Component/Device	Serial No.	Pre-Test %	Post-Test %	Spread (Pre/Post Delta), %	Shift, PPH	Skew, PSID	Flow Range Shift, PPH	Flow Midpoint Shift, PPH	Overall Rating	Hysteresis Area Change (PPH-DP)
FDV	1134	-1.1	44.3	45.4	-5.7	2.5	-6.6	-3.3	Non-Funct	212
Servo2	021	5.8	59.7	53.9	-3.6	-0.4	-0.7	-0.4	Severe+	1847

Effective Carbon - µgrams

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	138.7	67.1	65.8	77.0	62.1					
BFA	246.8	1324.1	4425.2	8731.2	10573.6	12032.8	12432.1	12175.2	11837.6	7926.5
Total FCOC Carbon, µgrams	410.7	µgrams	0.4	mgrams						
Total BFA Carbon, µgrams	81705.2	µgrams	81.7	mgrams						

SCREENS	Total Carbon, µg	Background Carbon, µg	Effective Carbon, µg	MWWT Start	MWWT End	Delta BFA MWWT	TE	BFA AWWT Start	BFA AWWT End	Delta BFA AWWT
TMS	90.0	0.3	89.7	510.03	616.45	107.68	MAX	492.25	569.80	77.55
F303	150.2	25.4	124.8	502.13	591.02	88.90	TE325	SV Inlet	FDV Inlet	BFA Inlet
F304	235.2	12.9	222.3	510.03	613.13	103.10	TE324	(TE702)	(TE313)	(TE316)
F305	0.0	0.0	0.0	508.21	615.89	107.68	TE323	341	328	324
F702	164.3	12.9	151.4	509.02	616.45	107.43	TE322			

Effective Carbon Deposition - µgrams/cm^2

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	38.0	18.4	18.0	21.1	17.0					
BFA	143.3	768.6	2568.6	5068.0	6137.5	6984.4	7216.2	7067.1	6871.1	4600.9

TMS Mass Change - grams

Component/Device	Tare, g	Mass, g	Mass Gain, g
TMS	0.08670	0.08711	0.00041
F303	7.11634	7.11489	-0.00145
F304	3.03799	3.03848	0.00049
F305	0.00000	0.00000	0.00000
F702	3.04726	3.04798	0.00072

Hysteresis Ratings:

- NONE: indicating that the pre-test and post-test hysteresis curves, for all intents and purposes, are nearly indistinguishable from one another. Minor differences may be seen between the pre-test and post-test curves but these are very small.
- Minor: There are small differences between per- and post-test curves. The spread for these curves is typically within 5% of one another. There may be some small changes in shift and skew for the valve. This degree of hysteresis would not be expected to alter the functional nature of the valve.
- Moderate: There are definite differences between pre-and post-test curves. There may be definite differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically between 5% and 15%. This degree of hysteresis might be expected to alter the functional nature of the valve.
- Severe: There are pronounce differences between pre-and post-test curves. There may be pronounced differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically in excess 15%. This degree of hysteresis would be considered out-of-spec for the valve.
- Non-Functional: There are major differences between pre-and post-test curves. There may be major differences in shift and skew as well. The hysteresis curve will exhibit flat segments (either vertically or horizontally). Shift and skew have majorly changed the performance envelope of the valve. This degree of hysteresis would cause the valve to be non-functional or unresponsive over small or large portions of the performance range of the valve.

Figure J - 1 Run 154 Data Summary

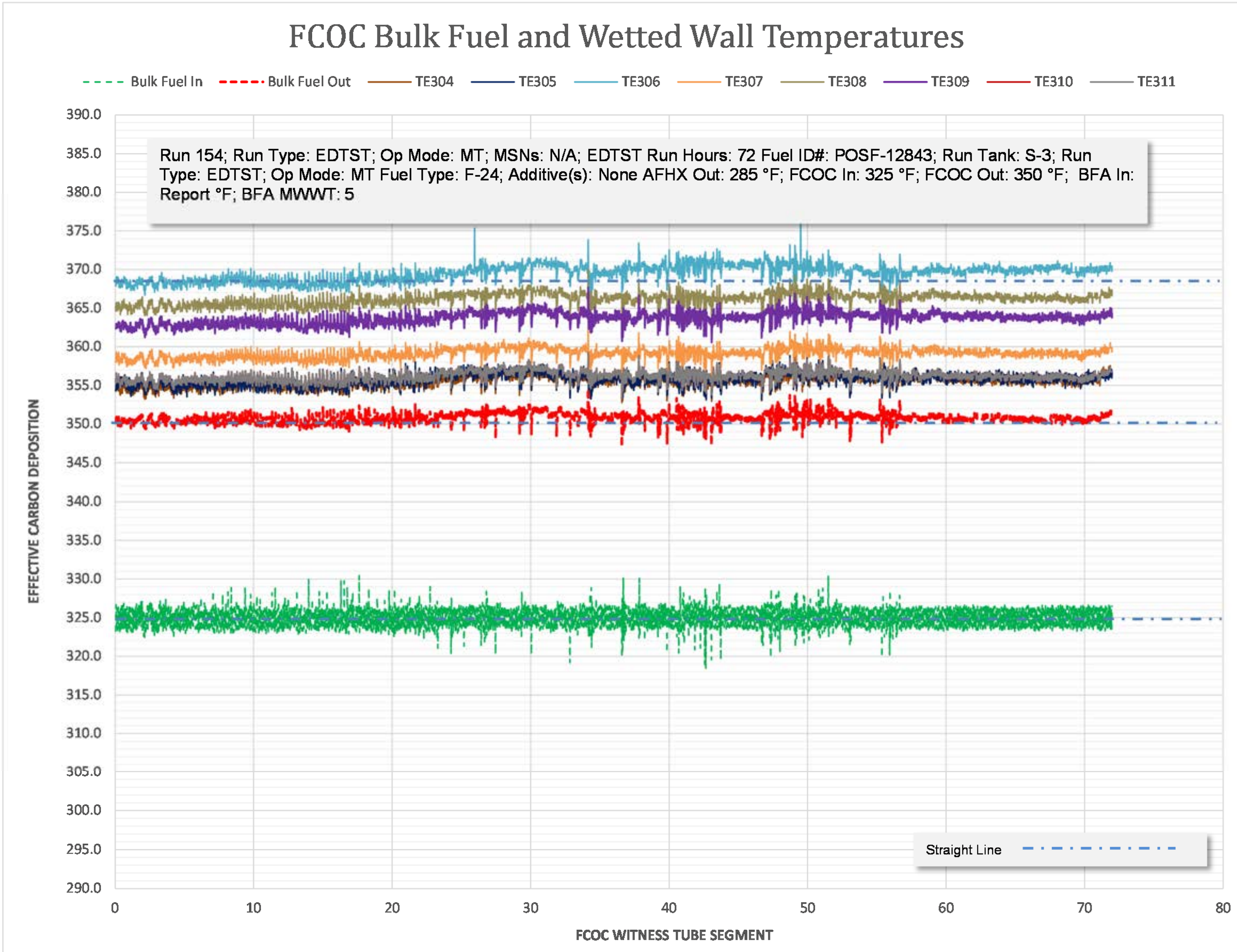


Figure J - 2 FCOC Bulk Fuel and Wetted Wall Temperatures

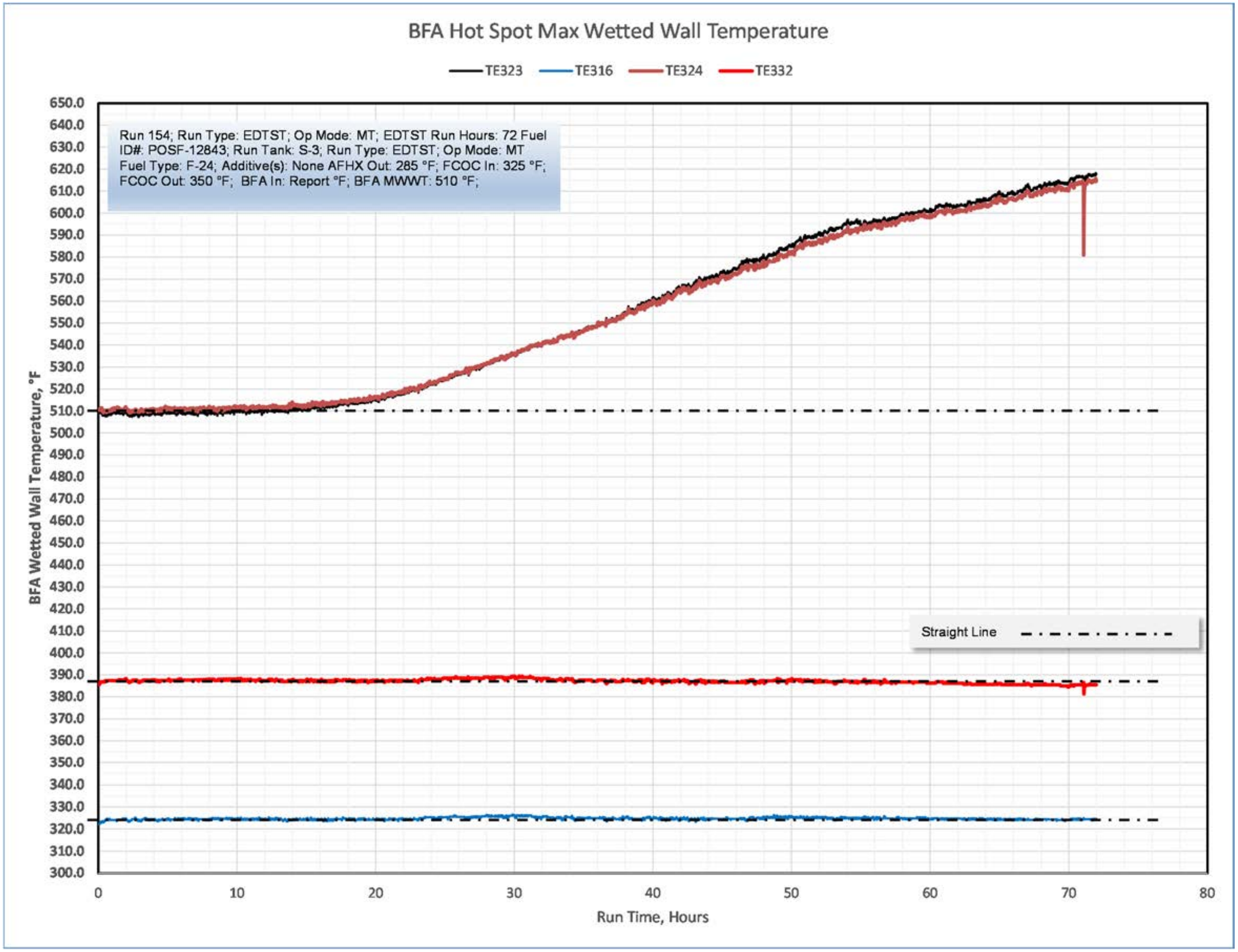


Figure J - 3 BFA Hot Spot Max Wetted Wall And Bulk Fuel Temperatures

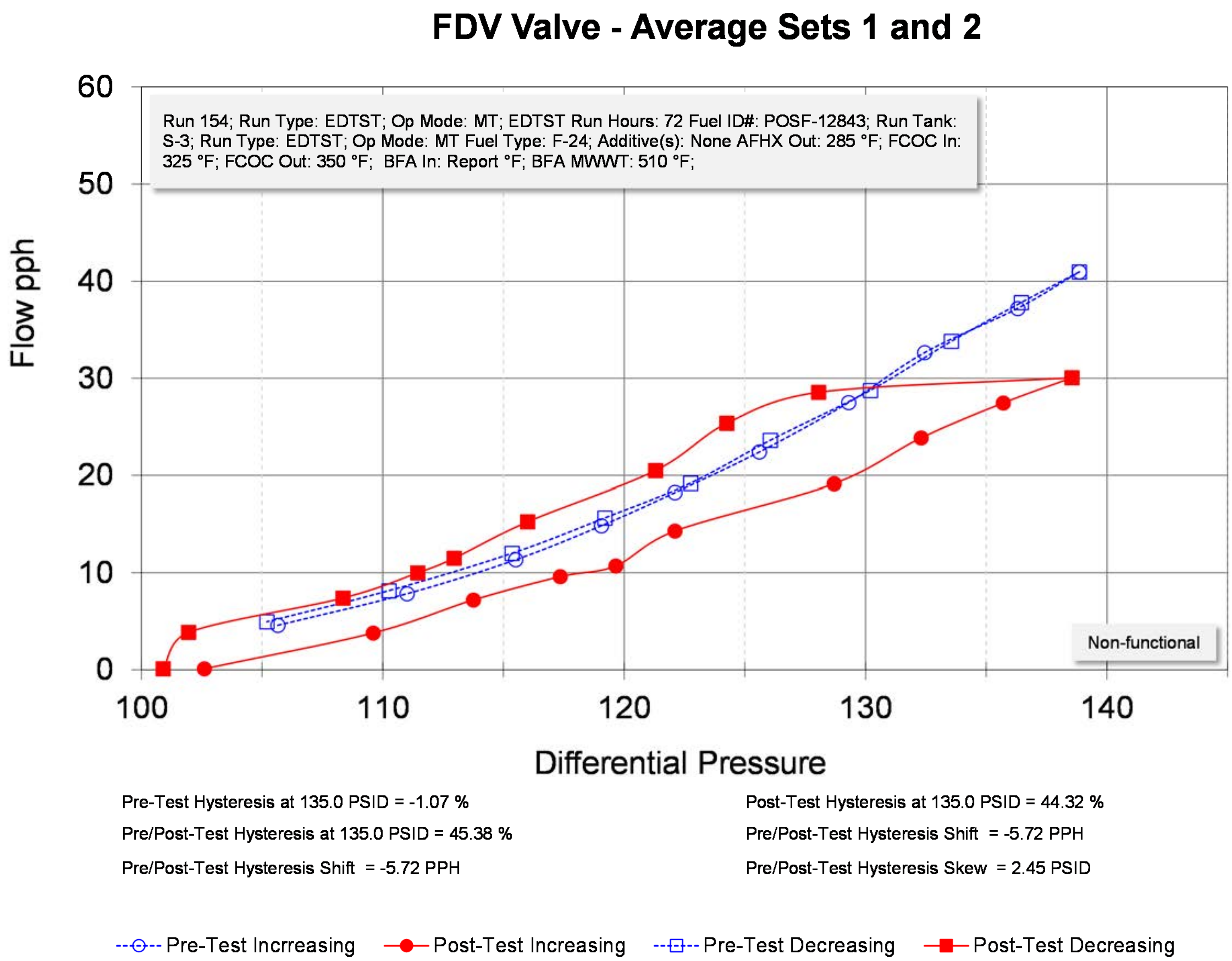


Figure J - 4 FDV Hysteresis

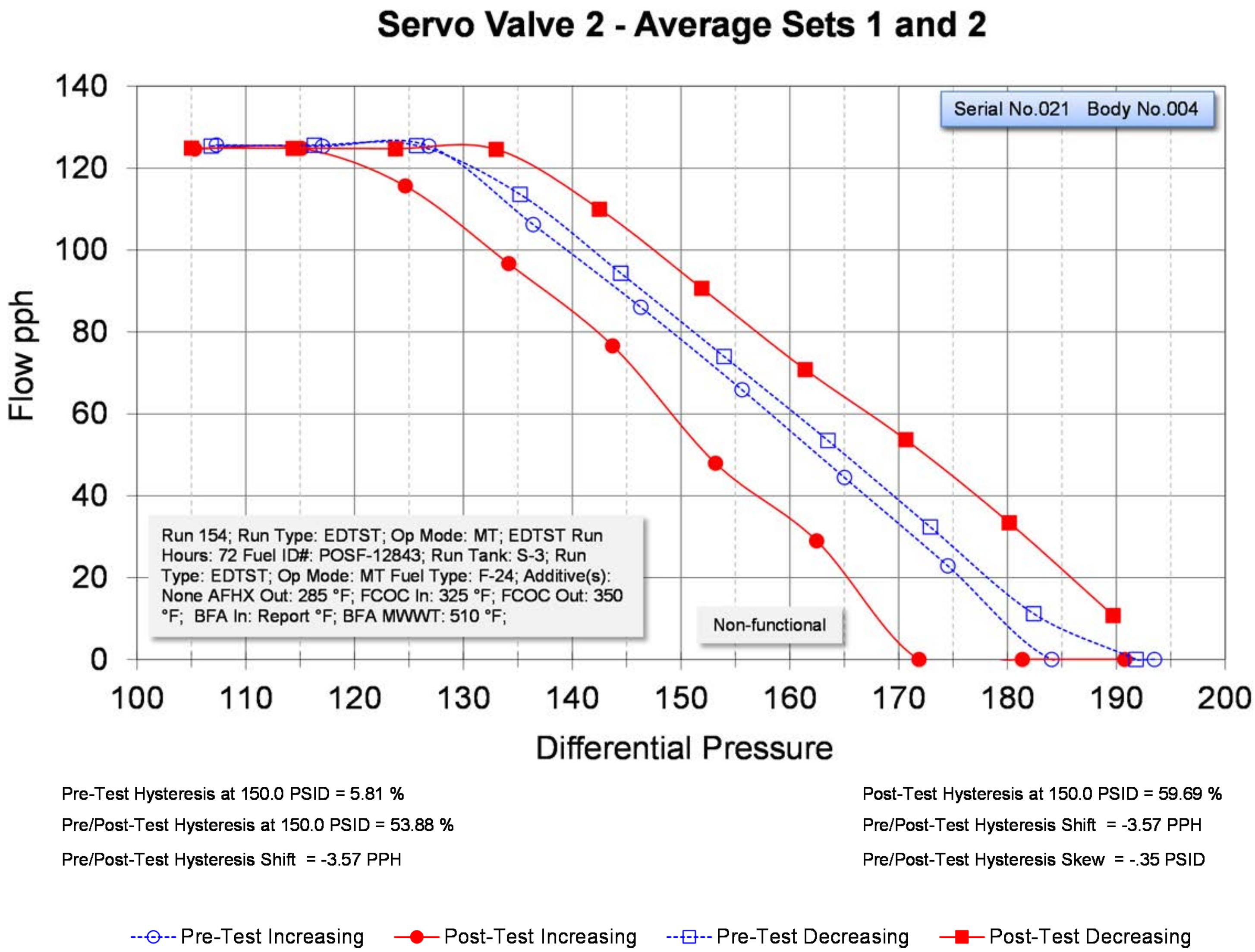


Figure J - 5 Servo Valve Hysteresis

FDV Components Comparison to Clean
Run 154

Figure J - 6 FDV Components - Comparison to Clean

Servo Valve and Nozzle Screen Simulator Components – Comparison To Clean - Run 154

Run 154

Clean

Run 154 MT POSF-12843

Figure J - 7 Servo Valve and Nozzle Screen Components - Comparison to Clean

TMS Screens Comparison to Clean - Run 154

Run 154

CLEAN

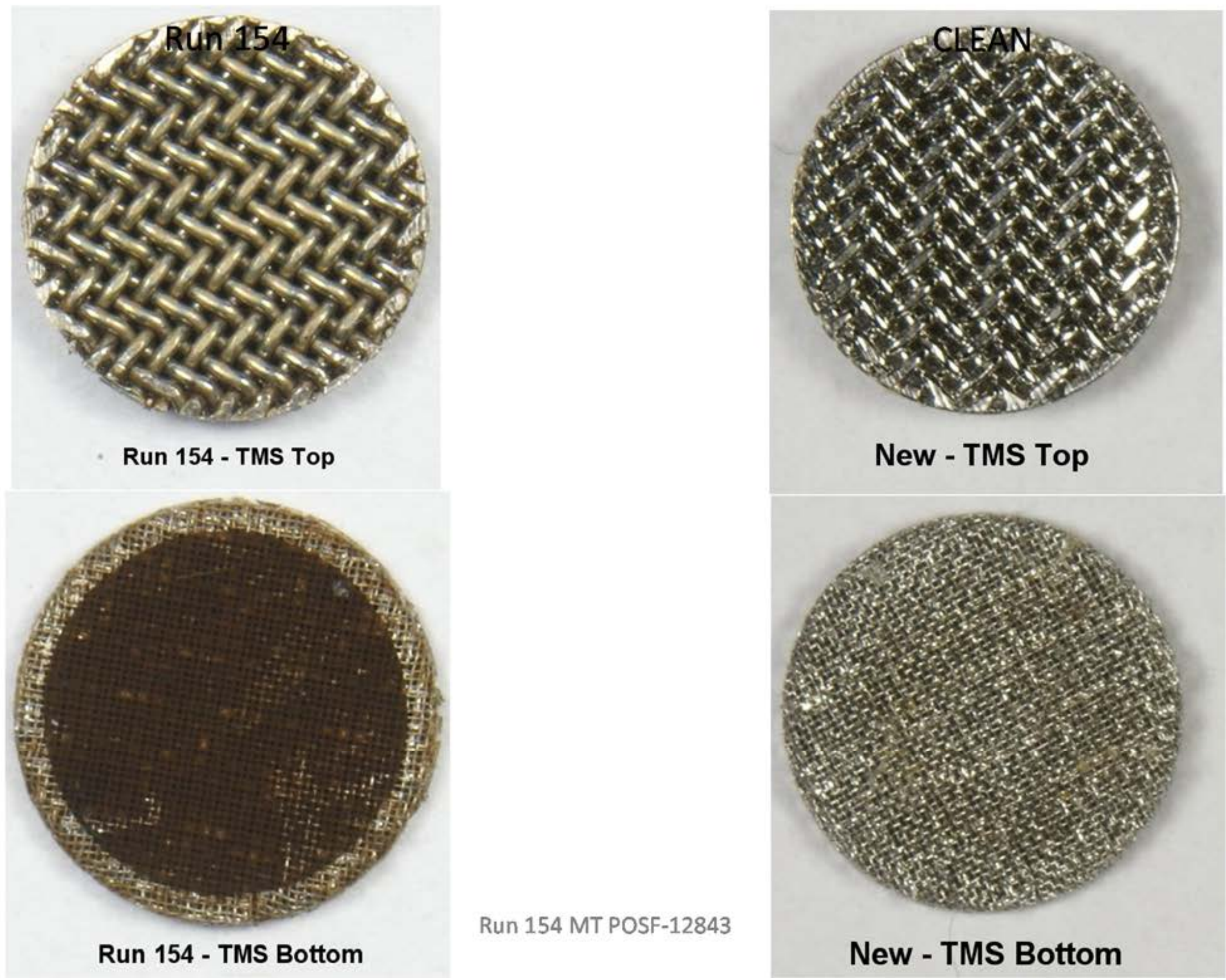


Figure J - 8 TMS Screen Top and Bottom - Comparison to Clean

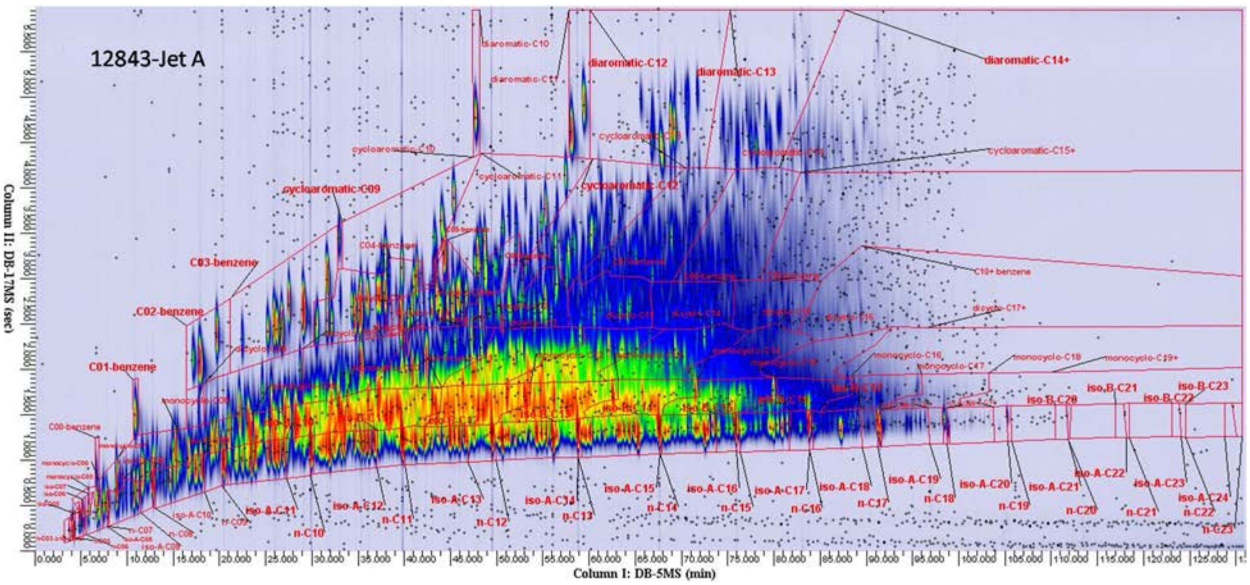


Figure J - 9 GCxGC Summary POSF-12843 Neat Fuel

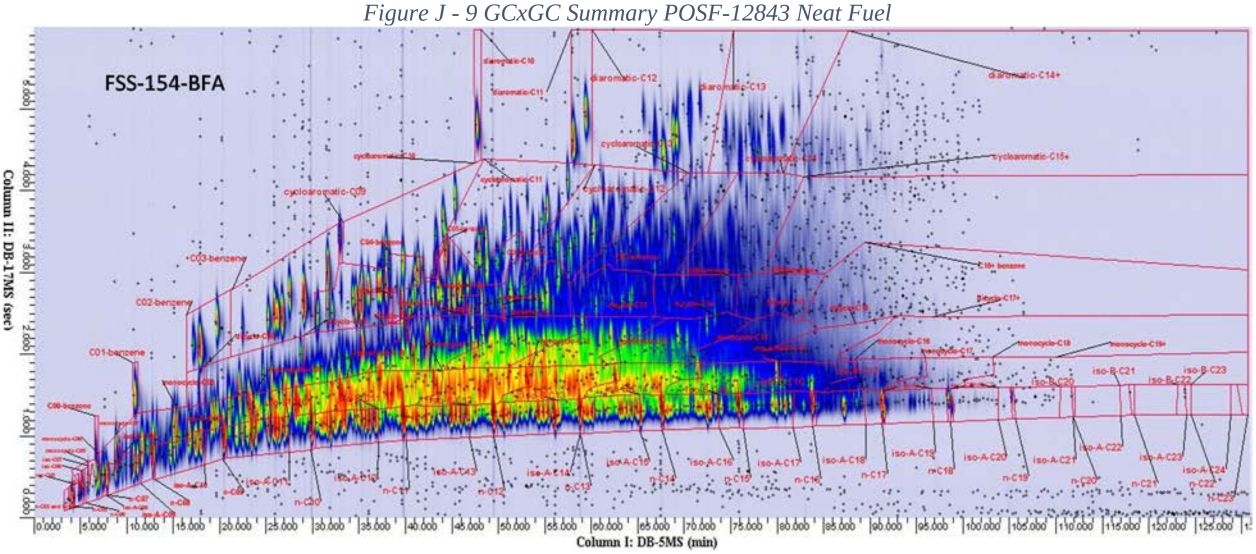


Figure J - 10 GCxGC Summary POSF-12843 Run 154 BFA Outlet

Table J - 1 GCxGC Tabulated Data POSF-12843 Jet A Neat and Run 154 BFA Outlet

GCxGC Summary				
Hydrogen content (weight %)	13.9		13.9	
Average Molecular Wt (g/mole)	163		163	
	POSF-12843- Jet A		**FSS154-BFA**	
	Weight %	**Volume %**	**Weight %**	**Volume %**
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	<0.01	<0.01
toluene (C07)	0.12	0.11	0.11	0.10
C2-benzene (C08)	0.56	0.52	0.54	0.50
C3-benzene (C09)	1.90	1.77	1.87	1.74
C4-benzene (C10)	2.45	2.29	2.43	2.27
C5-benzene (C11)	1.86	1.72	1.87	1.74
C6-benzene (C12)	1.62	1.51	1.62	1.51
C7-benzene (C13)	1.00	0.93	1.02	0.95
C8-benzene (C14)	0.83	0.77	0.80	0.74
C9-benzene (C15)	0.59	0.55	0.60	0.56
C10+-benzene (C16+)	0.40	0.37	0.39	0.37
Total Alkylbenzenes	**11.35**	10.56	**11.26**	10.47
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.10	0.08
diaromatic-C11	0.42	0.33	0.42	0.33
diaromatic-C12	0.73	0.58	0.72	0.58
diaromatic-C13	0.51	0.42	0.51	0.41
diaromatic-C14+	0.31	0.26	0.28	0.23
Total Alkylnaphthalenes	**2.08**	1.67	**2.03**	1.63
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.04	0.04	0.04	0.04
cycloaromatic-C10	0.37	0.30	0.36	0.30
cycloaromatic-C11	0.87	0.75	0.89	0.76
cycloaromatic-C12	1.16	1.01	1.16	1.01
cycloaromatic-C13	1.47	1.29	1.46	1.28
cycloaromatic-C14	0.83	0.73	0.86	0.75
cycloaromatics-C15+	0.41	0.36	0.42	0.37
Total Cycloaromatics	**5.16**	4.47	**5.20**	4.50
Total Aromatics	**18.59**	**16.70**	**18.48**	**16.60**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.22	0.27	0.20	0.24
C08-isoparaffins	0.44	0.50	0.42	0.48
C09-isoparaffins	0.84	0.94	0.83	0.93
C10-isoparaffins	3.27	3.60	3.24	3.58
C11-isoparaffins	4.25	4.59	4.40	4.74
C12-isoparaffins	3.56	3.85	3.63	3.93
C13-isoparaffins	3.40	3.59	3.57	3.78
C14-isoparaffins	3.18	3.34	3.17	3.33
C15-isoparaffins	2.29	2.39	2.36	2.46
C16-isoparaffins	1.06	1.10	1.07	1.11
C17-isoparaffins	0.56	0.58	0.52	0.54
C18-isoparaffins	0.15	0.15	0.14	0.14
C19-isoparaffins	0.08	0.08	0.08	0.08
C20-isoparaffins	0.03	0.03	0.03	0.03
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01
Total iso-Paraffins	**23.31**	25.01	**23.65**	25.37

n-Paraffins				
n-C07 & lower	0.17	0.20	0.16	0.19
n-C08	0.43	0.49	0.41	0.47
n-C09	1.01	1.13	0.99	1.10
n-C10	2.54	2.79	2.48	2.72
n-C11	3.01	3.26	2.99	3.24
n-C12	2.52	2.70	2.60	2.78
n-C13	2.00	2.12	2.02	2.13
n-C14	1.54	1.62	1.55	1.63
n-C15	0.89	0.93	0.92	0.96
n-C16	0.43	0.44	0.43	0.45
n-C17	0.20	0.20	0.19	0.20
n-C18	0.04	0.04	0.04	0.04
n-C19	<0.01	<0.01	<0.01	<0.01
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**14.80**	15.93	**14.80**	15.93
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.42	0.43	0.41	0.42
C08-monocyclocycloparaffins	0.63	0.64	0.59	0.60
C09-monocyclocycloparaffins	1.82	1.84	1.79	1.81
C10-monocyclocycloparaffins	4.60	4.50	4.66	4.57
C11-monocyclocycloparaffins	6.32	6.36	6.11	6.14
C12-monocyclocycloparaffins	5.57	5.57	5.41	5.41
C13-monocyclocycloparaffins	5.07	5.02	4.88	4.82
C14-monocyclocycloparaffins	3.15	3.12	3.27	3.24
C15-monocyclocycloparaffins	2.10	2.07	1.98	1.96
C16-monocyclocycloparaffins	0.86	0.85	0.85	0.84
C17-monocyclocycloparaffins	0.33	0.32	0.39	0.39
C18-monocyclocycloparaffins	0.05	0.05	0.05	0.05
C19+-monocyclocycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Monocycloparaffins	**30.93**	30.78	**30.41**	30.25
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.45	0.42	0.48	0.44
C10-dicycloparaffins	1.01	0.90	1.07	0.95
C11-dicycloparaffins	2.32	2.17	2.27	2.14
C12-dicycloparaffins	2.69	2.54	2.76	2.61
C13-dicycloparaffins	3.00	2.83	3.31	3.12
C14-dicycloparaffins	1.94	1.83	1.81	1.71
C15-dicycloparaffins	0.60	0.56	0.60	0.56
C16-dicycloparaffins	0.21	0.20	0.20	0.19
C17+-dicycloparaffins	0.04	0.03	0.04	0.03
Total Dicycloparaffins	**12.27**	11.51	**12.56**	11.77
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.09	0.07	0.09	0.08
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.09**	0.08	**0.10**	0.08
Total Cycloparaffins	**43.29**	42.36	**43.06**	42.11
Average Molecular Formula - C	11.7		11.7	
Average Molecular Formula - H	22.4		22.4	

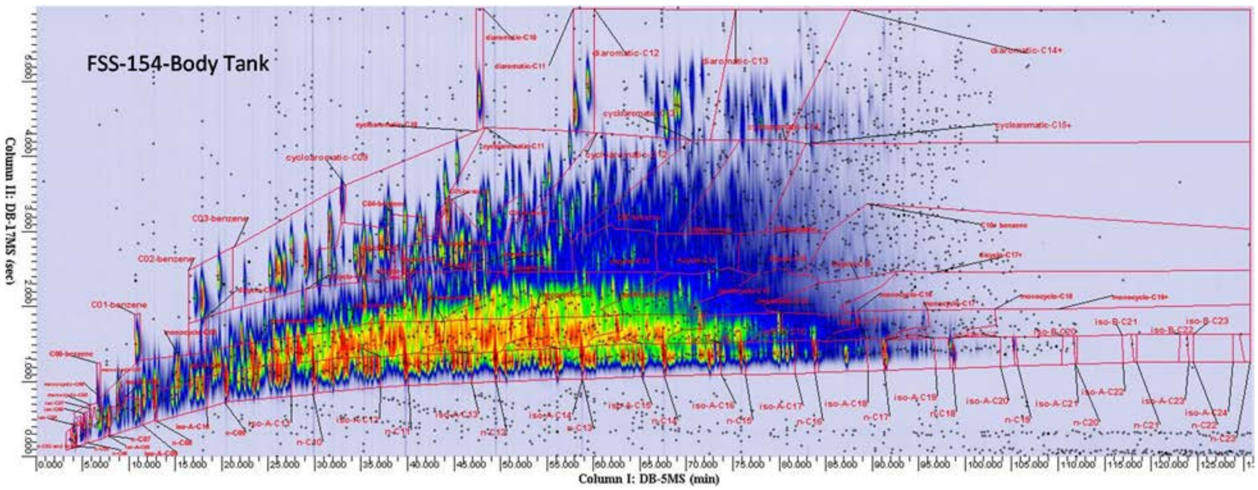


Figure J - 11 GCxGC Summary Fuel From Body Tank

Table J - 2 GCxGC Tabulated Data - Fuel From Body Tank at the End Of Run

GCxGC Summary				
Hydrogen content (weight %)	13.9		13.9	
Average Molecular Wt (g/mole)	163		163	
	POSF-12843- Jet A		FSS154-Body Tank	
	Weight %	Volume %	Weight %	Volume %
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	<0.01	<0.01
toluene (C07)	0.12	0.11	0.11	0.10
C2-benzene (C08)	0.56	0.52	0.54	0.50
C3-benzene (C09)	1.90	1.77	1.86	1.73
C4-benzene (C10)	2.45	2.29	2.44	2.27
C5-benzene (C11)	1.86	1.72	1.87	1.74
C6-benzene (C12)	1.62	1.51	1.62	1.51
C7-benzene (C13)	1.00	0.93	0.98	0.91
C8-benzene (C14)	0.83	0.77	0.78	0.72
C9-benzene (C15)	0.59	0.55	0.61	0.57
C10+-benzene (C16+)	0.40	0.37	0.39	0.36
Total Alkylbenzenes	**11.35**	10.56	**11.20**	10.41
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.10	0.08
diaromatic-C11	0.42	0.33	0.42	0.33
diaromatic-C12	0.73	0.58	0.72	0.58
diaromatic-C13	0.51	0.42	0.51	0.41
diaromatic-C14+	0.31	0.26	0.28	0.23
Total Alkylnaphthalenes	**2.08**	1.67	**2.03**	1.63
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.04	0.04	0.04	0.04
cycloaromatic-C10	0.37	0.30	0.34	0.28
cycloaromatic-C11	0.87	0.75	0.89	0.76
cycloaromatic-C12	1.16	1.01	1.20	1.05
cycloaromatic-C13	1.47	1.29	1.43	1.25
cycloaromatic-C14	0.83	0.73	0.84	0.74
cycloaromatics-C15+	0.41	0.36	0.44	0.39
Total Cycloaromatics	**5.16**	4.47	**5.19**	4.50
Total Aromatics	**18.59**	**16.70**	**18.42**	**16.53**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.22	0.27	0.21	0.25
C08-isoparaffins	0.44	0.50	0.42	0.48
C09-isoparaffins	0.84	0.94	0.78	0.87
C10-isoparaffins	3.27	3.60	3.27	3.61
C11-isoparaffins	4.25	4.59	4.28	4.62
C12-isoparaffins	3.56	3.85	3.61	3.91
C13-isoparaffins	3.40	3.59	3.58	3.79
C14-isoparaffins	3.18	3.34	3.23	3.39
C15-isoparaffins	2.29	2.39	2.36	2.46
C16-isoparaffins	1.06	1.10	1.08	1.11
C17-isoparaffins	0.56	0.58	0.51	0.53
C18-isoparaffins	0.15	0.15	0.14	0.14
C19-isoparaffins	0.08	0.08	0.08	0.08
C20-isoparaffins	0.03	0.03	0.03	0.03
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01
Total iso-Paraffins	**23.31**	25.01	**23.58**	25.27

n-Paraffins				
n-C07 & lower	0.17	0.20	0.16	0.19
n-C08	0.43	0.49	0.41	0.47
n-C09	1.01	1.13	0.99	1.10
n-C10	2.54	2.79	2.59	2.84
n-C11	3.01	3.26	2.99	3.24
n-C12	2.52	2.70	2.60	2.78
n-C13	2.00	2.12	2.02	2.14
n-C14	1.54	1.62	1.52	1.60
n-C15	0.89	0.93	0.92	0.96
n-C16	0.43	0.44	0.43	0.44
n-C17	0.20	0.20	0.20	0.20
n-C18	0.04	0.04	0.04	0.04
n-C19	<0.01	<0.01	<0.01	<0.01
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**14.80**	15.93	**14.88**	16.01
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.42	0.43	0.40	0.42
C08-monocyclocycloparaffins	0.63	0.64	0.60	0.61
C09-monocyclocycloparaffins	1.82	1.84	1.82	1.84
C10-monocyclocycloparaffins	4.60	4.50	4.61	4.51
C11-monocyclocycloparaffins	6.32	6.36	6.67	6.70
C12-monocyclocycloparaffins	5.57	5.57	5.27	5.27
C13-monocyclocycloparaffins	5.07	5.02	5.05	4.99
C14-monocyclocycloparaffins	3.15	3.12	3.20	3.17
C15-monocyclocycloparaffins	2.10	2.07	2.02	2.00
C16-monocyclocycloparaffins	0.86	0.85	0.89	0.88
C17-monocyclocycloparaffins	0.33	0.32	0.41	0.40
C18-monocyclocycloparaffins	0.05	0.05	0.05	0.05
C19+-monocyclocycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Monocycloparaffins	**30.93**	30.78	**31.01**	30.84
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.45	0.42	0.47	0.43
C10-dicycloparaffins	1.01	0.90	0.97	0.87
C11-dicycloparaffins	2.32	2.17	2.03	1.91
C12-dicycloparaffins	2.69	2.54	2.72	2.56
C13-dicycloparaffins	3.00	2.83	3.10	2.92
C14-dicycloparaffins	1.94	1.83	1.91	1.80
C15-dicycloparaffins	0.60	0.56	0.59	0.55
C16-dicycloparaffins	0.21	0.20	0.19	0.18
C17+-dicycloparaffins	0.04	0.03	0.02	0.02
Total Dicycloparaffins	**12.27**	11.51	**12.02**	11.26
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.09	0.07	0.09	0.08
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.09**	0.08	**0.10**	0.08
Total Cycloparaffins	**43.29**	42.36	**43.12**	42.19
Average Molecular Formula - C	11.7		11.7	
Average Molecular Formula - H	22.4		22.5	

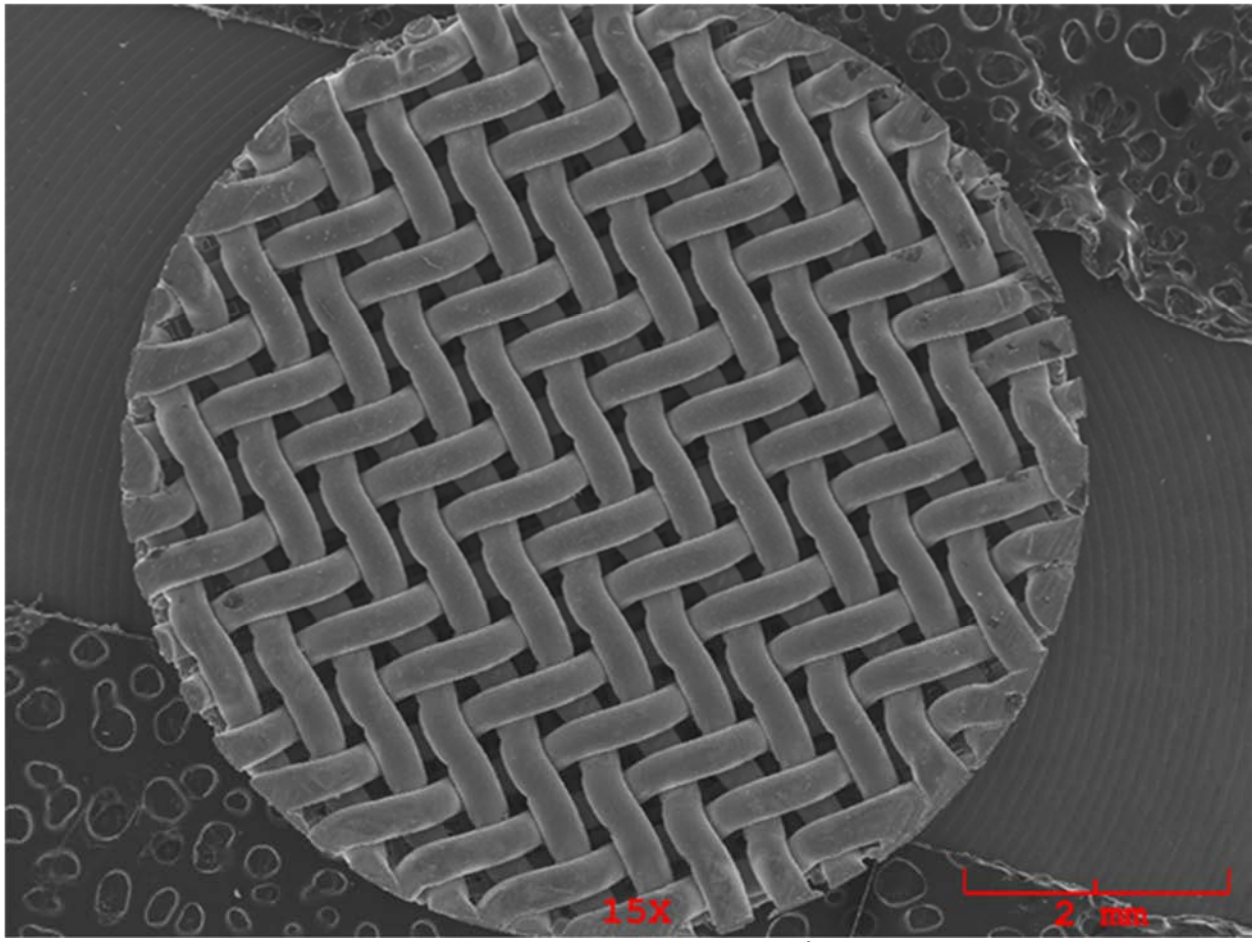
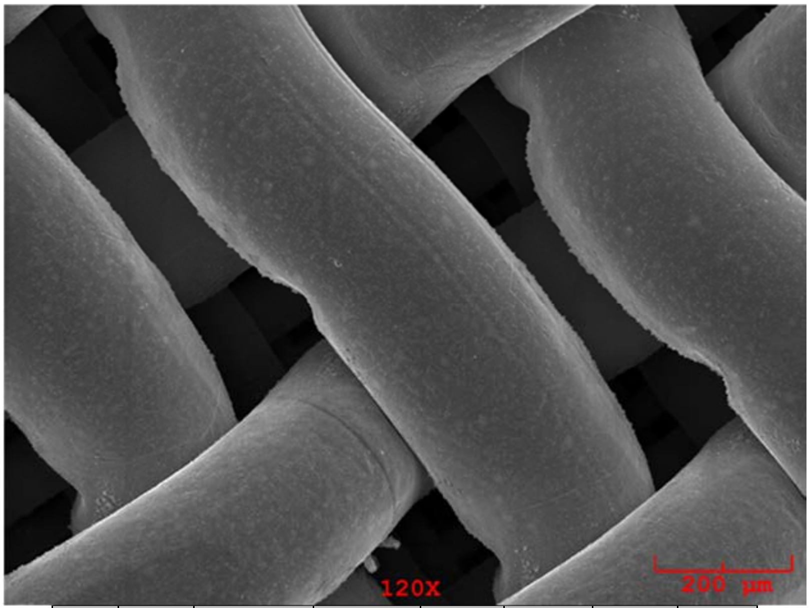


Figure J - 12 TMS Screen, Top, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	9.89	3.923	wt.%	0.369	0.415	
O	Ka	9.50	1.373	wt.%	0.125	0.134	
Al	Ka	6.16	0.591	wt.%	0.100	0.134	
Si	Ka	4.13	0.320	wt.%	0.082	0.116	
S	Ka	27.93	1.699	wt.%	0.092	0.101	
Cl	Ka	0.91	0.056	wt.%	0.069	0.104	
K	Ka	0.63	0.038	wt.%	0.067	0.101	
Ca	Ka	2.08	0.126	wt.%	0.066	0.098	
Cr	Ka	196.02	16.744	wt.%	0.255	0.133	
Fe	Ka	458.52	64.053	wt.%	0.615	0.217	
Ni	Ka	39.81	8.265	wt.%	0.317	0.273	
Cu	Ka	4.16	1.069	wt.%	0.228	0.310	
Zn	Ka	5.61	1.745	wt.%	0.275	0.355	
			100.000	wt.%			Total

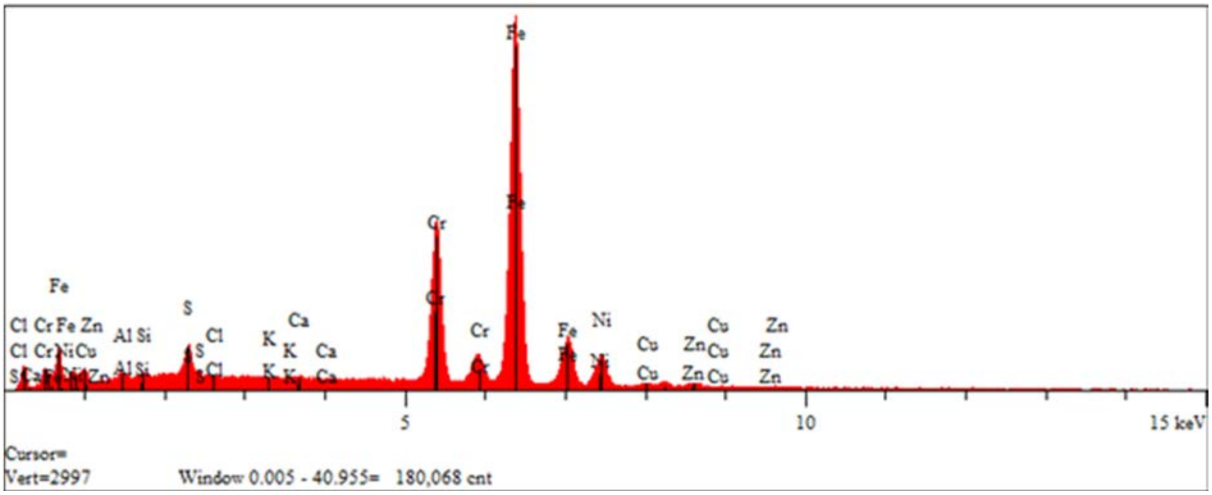


Figure J - 13 TMS Screen Top, 120X and EDX Elemental Analysis

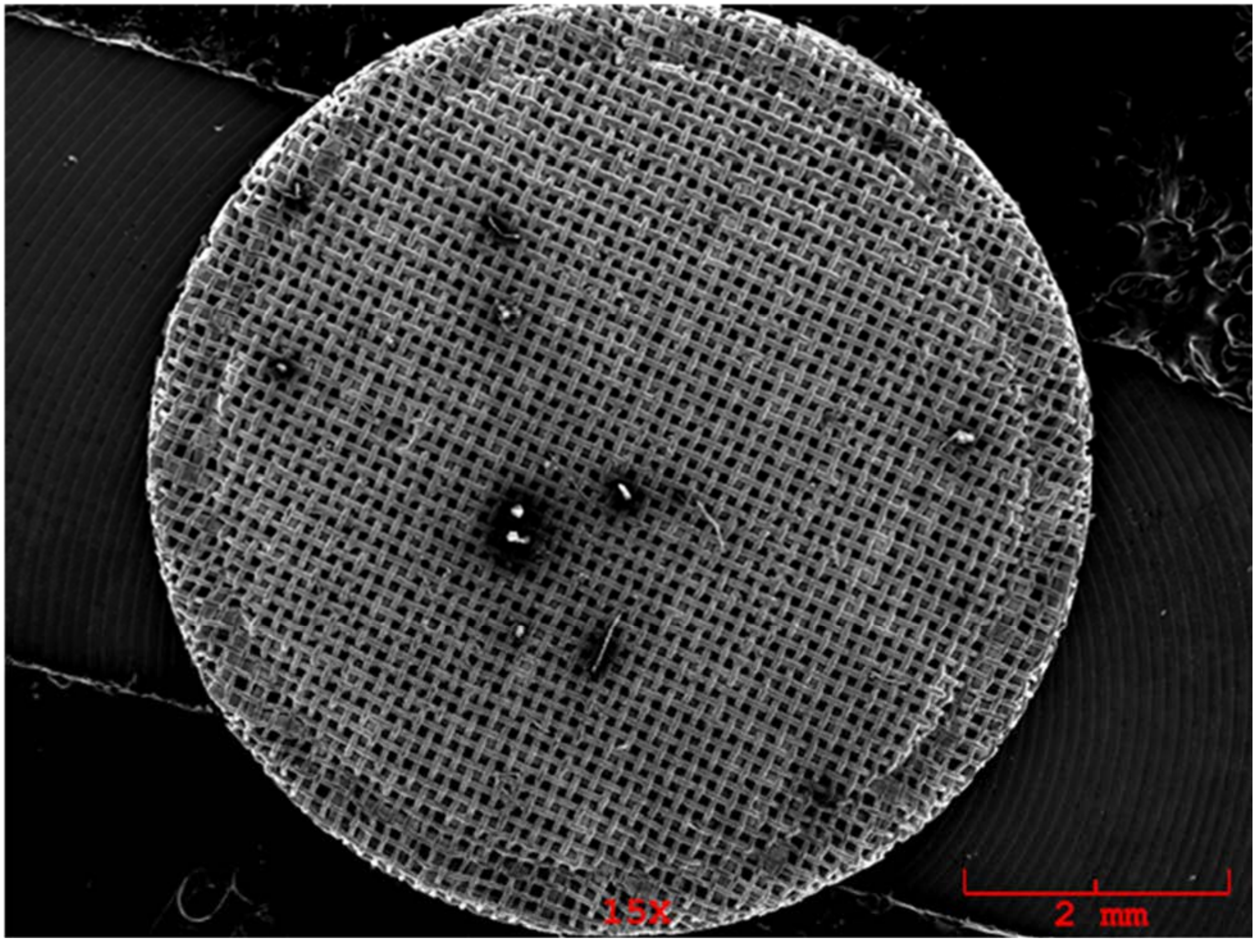
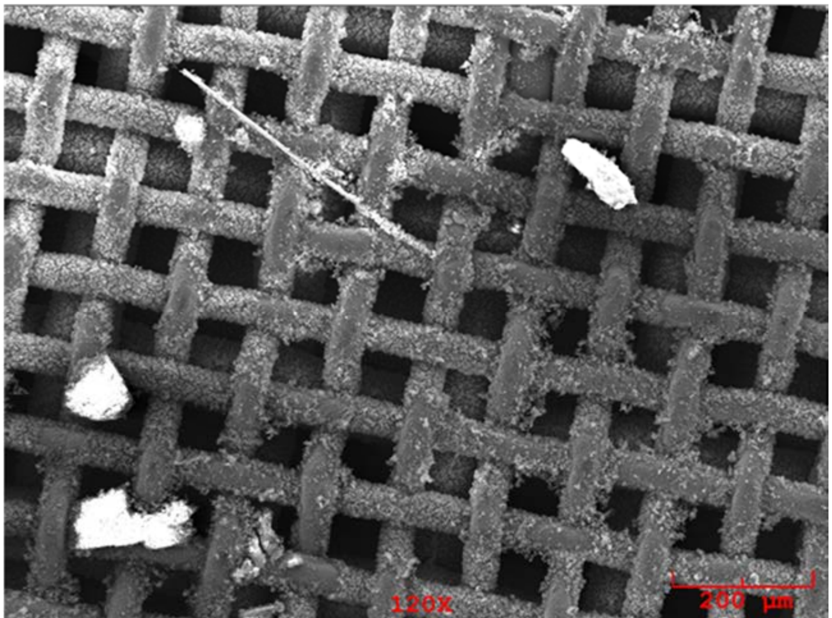


Figure J - 14 TMS Screen, Bottom, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	36.51	24.306	wt.%	0.922	0.689	
O	Ka	18.74	6.128	wt.%	0.336	0.278	
Al	Ka	6.93	0.753	wt.%	0.112	0.147	
Si	Ka	10.46	0.946	wt.%	0.103	0.130	
S	Ka	137.23	10.425	wt.%	0.195	0.121	
Cl	Ka	3.73	0.312	wt.%	0.091	0.130	
K	Ka	6.07	0.510	wt.%	0.090	0.121	
Ca	Ka	5.57	0.479	wt.%	0.088	0.120	
Cr	Ka	69.97	8.829	wt.%	0.235	0.158	
Fe	Ka	167.78	31.303	wt.%	0.505	0.222	
Ni	Ka	12.73	3.384	wt.%	0.259	0.270	
Cu	Ka	8.71	2.942	wt.%	0.304	0.352	
Zn	Ka	23.50	9.682	wt.%	0.478	0.403	
			100.000	wt.%			Total

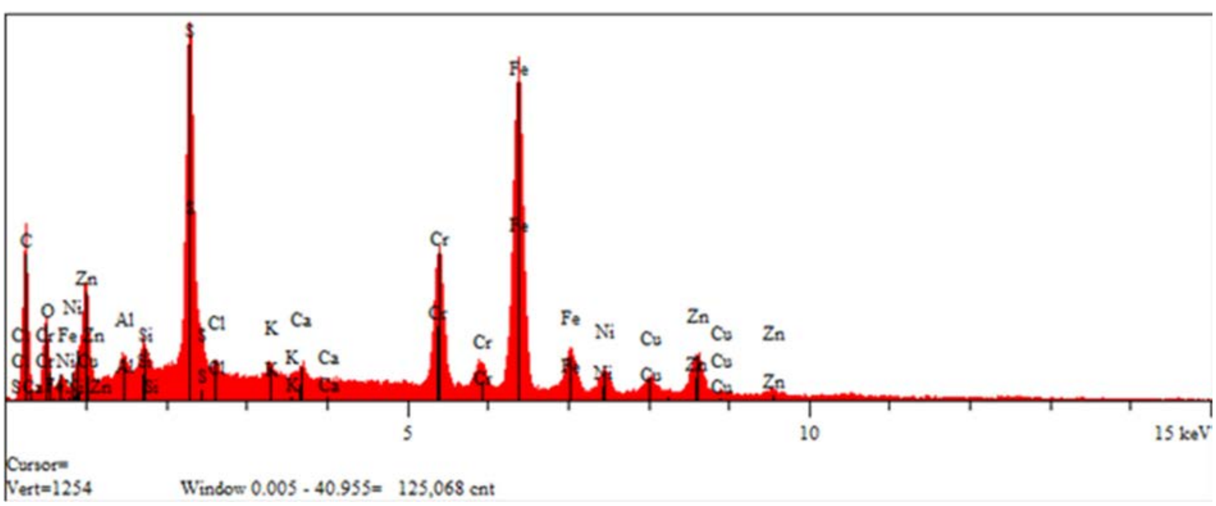


Figure J - 15 TMS Screen, Bottom, 120X and EDX Elemental Analysis

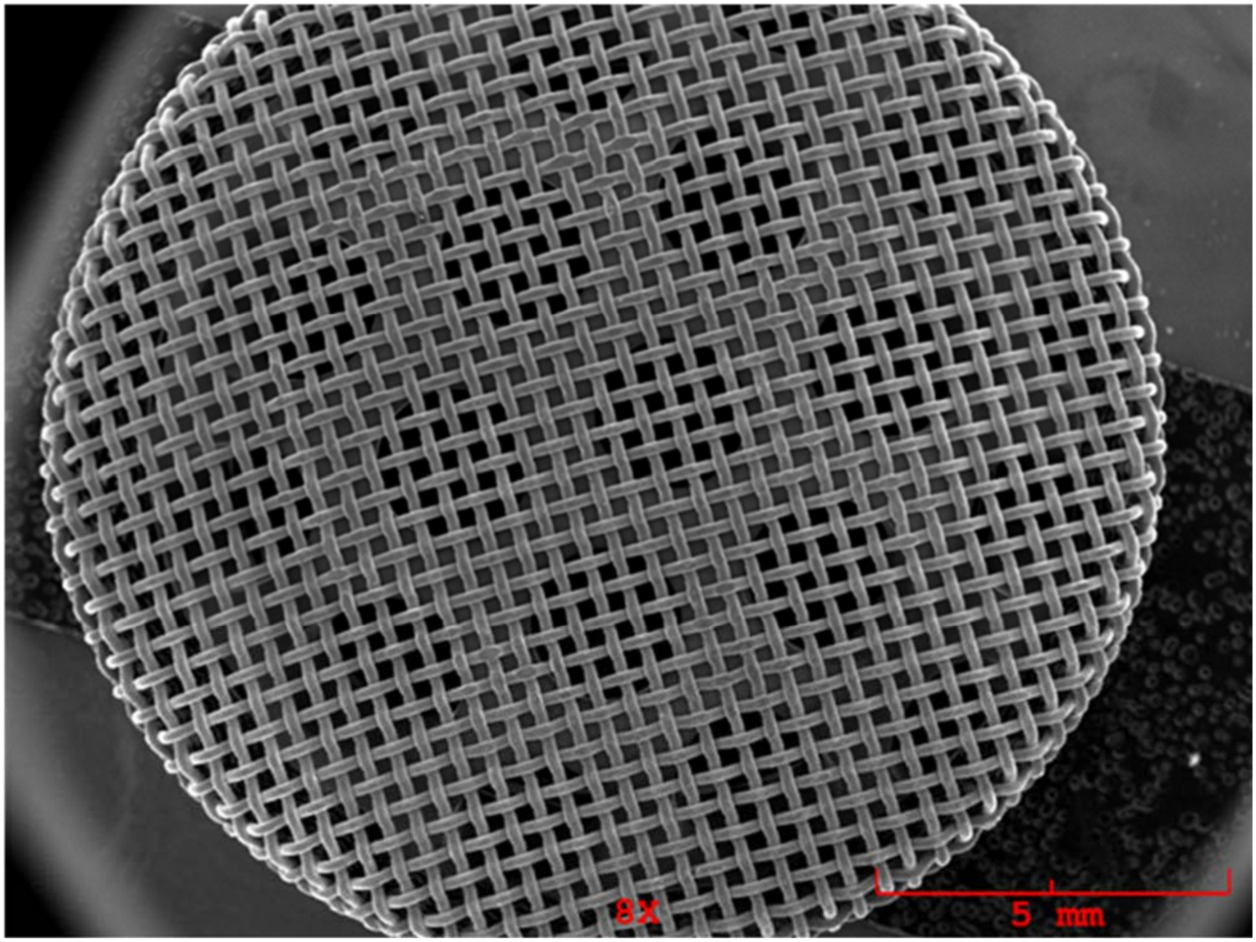
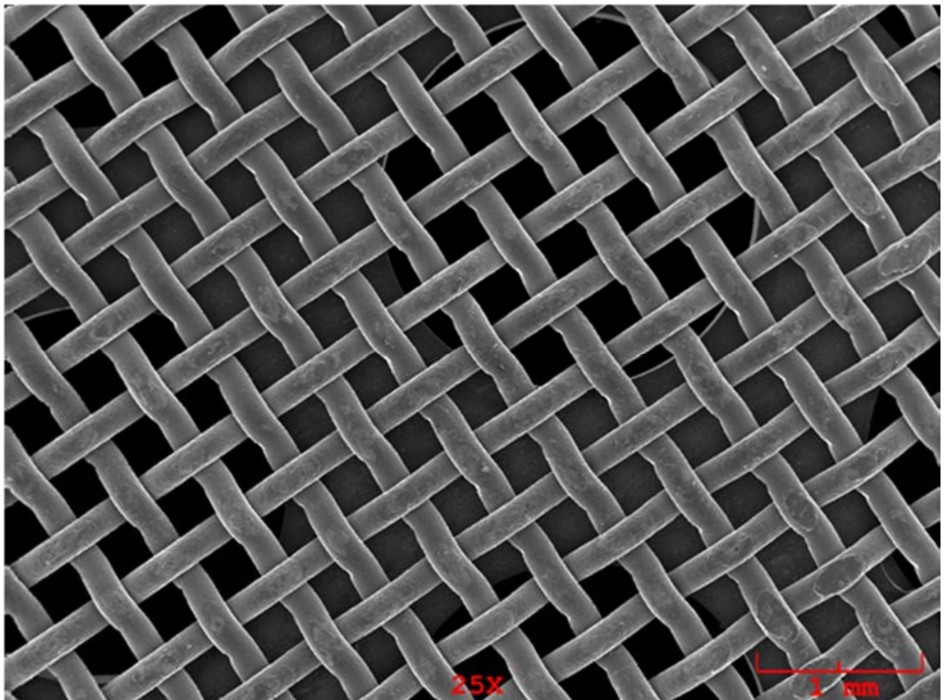


Figure J - 16 F303 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	4.31	2.779	wt.%	0.445	0.543	
O	Ka	2.30	0.525	wt.%	0.132	0.171	
Al	Ka	2.01	0.317	wt.%	0.123	0.175	
Si	Ka	6.15	0.780	wt.%	0.114	0.146	
S	Ka	12.31	1.228	wt.%	0.110	0.131	
Cr	Ka	120.33	16.564	wt.%	0.322	0.171	
Fe	Ka	294.88	67.066	wt.%	0.802	0.275	
Ni	Ka	28.96	9.842	wt.%	0.430	0.347	
Zn	Ka	1.77	0.899	wt.%	0.299	0.408	
			100.000	wt.%			Total

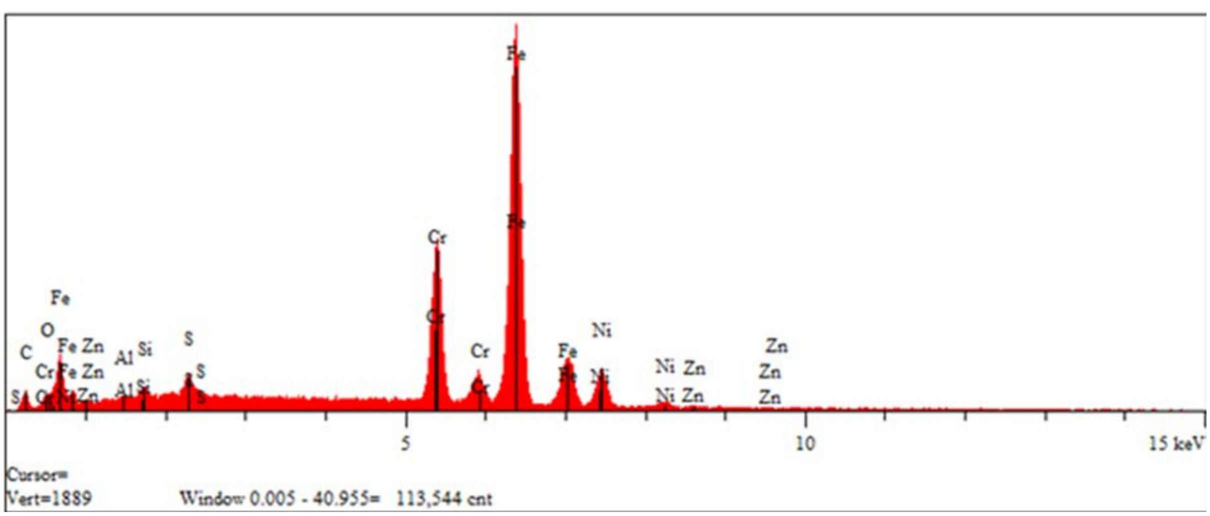


Figure J - 17 F303 Bottom 25X and EDX Elemental Analysis

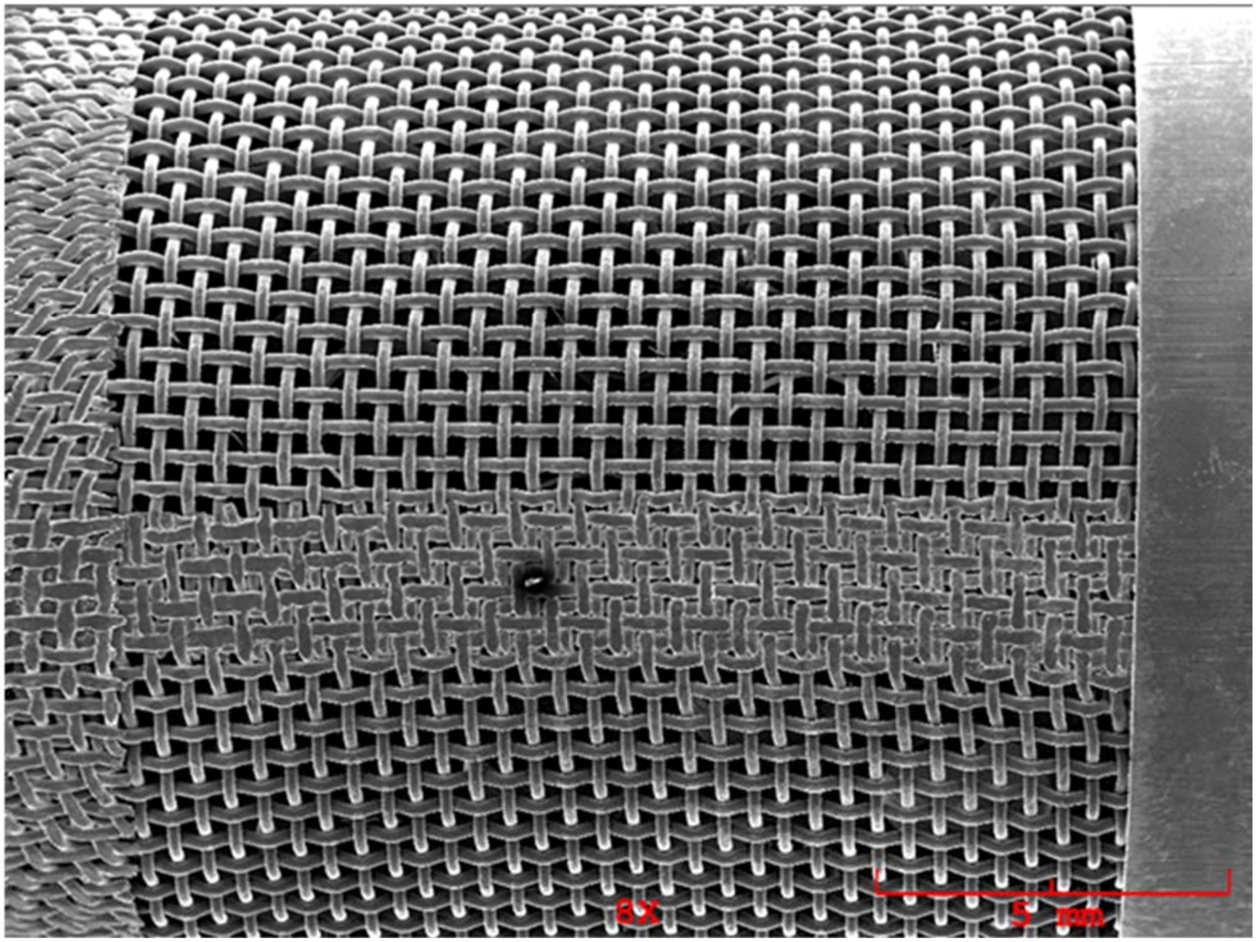
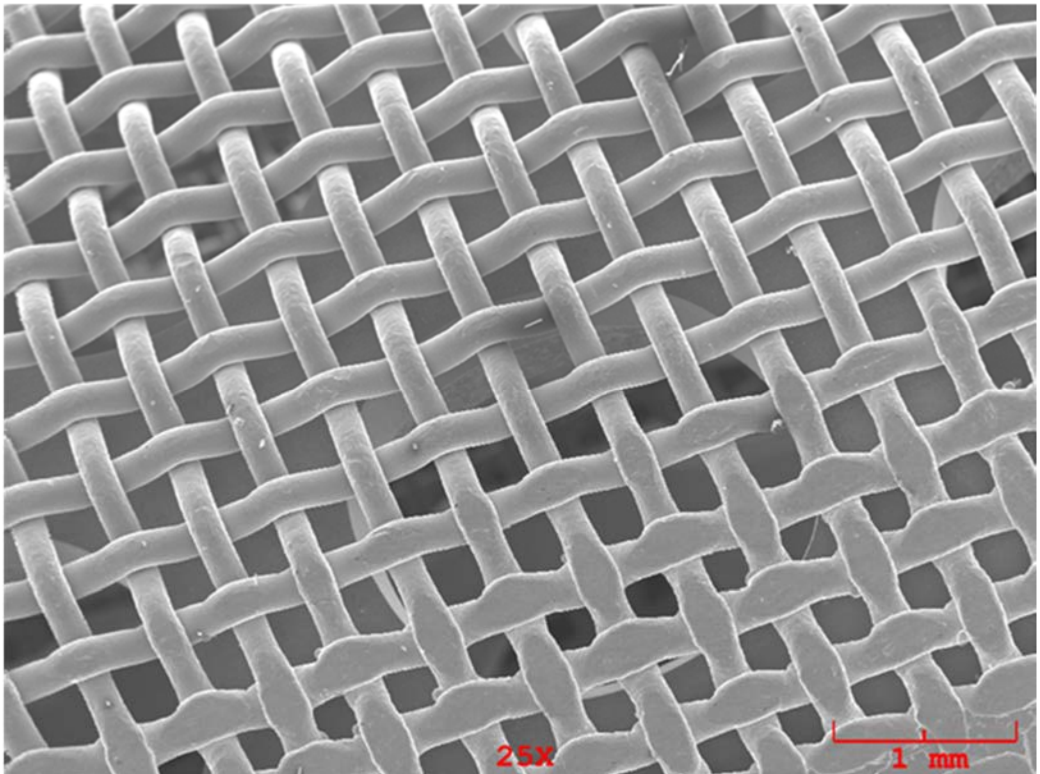


Figure J -18 F303 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	3.89	1.928	wt.%	0.370	0.481	
Al	Ka	1.95	0.240	wt.%	0.109	0.158	
Si	Ka	6.33	0.622	wt.%	0.101	0.135	
S	Ka	14.33	1.106	wt.%	0.095	0.115	
Cr	Ka	160.21	16.975	wt.%	0.284	0.145	
Fe	Ka	392.98	69.128	wt.%	0.716	0.246	
Ni	Ka	37.95	10.000	wt.%	0.382	0.309	
			100.000	wt.%			Total

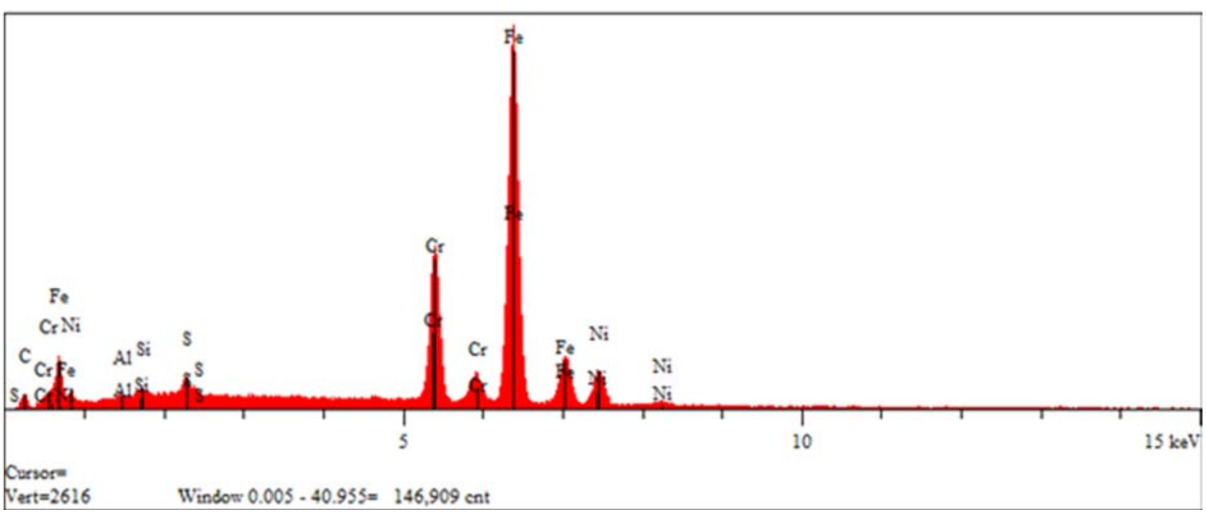


Figure J - 19 F303 Side 25X and EDX Elemental Analysis

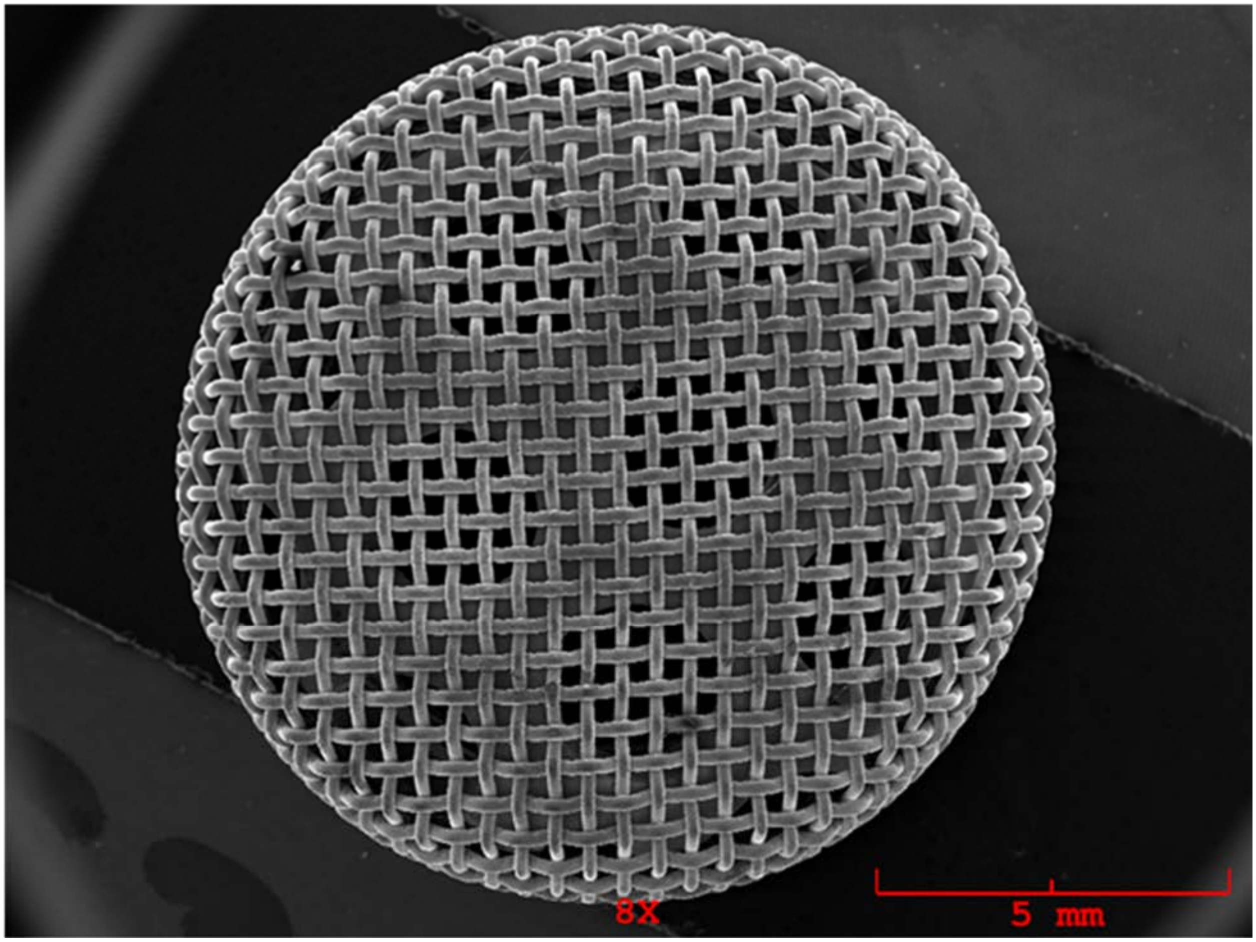
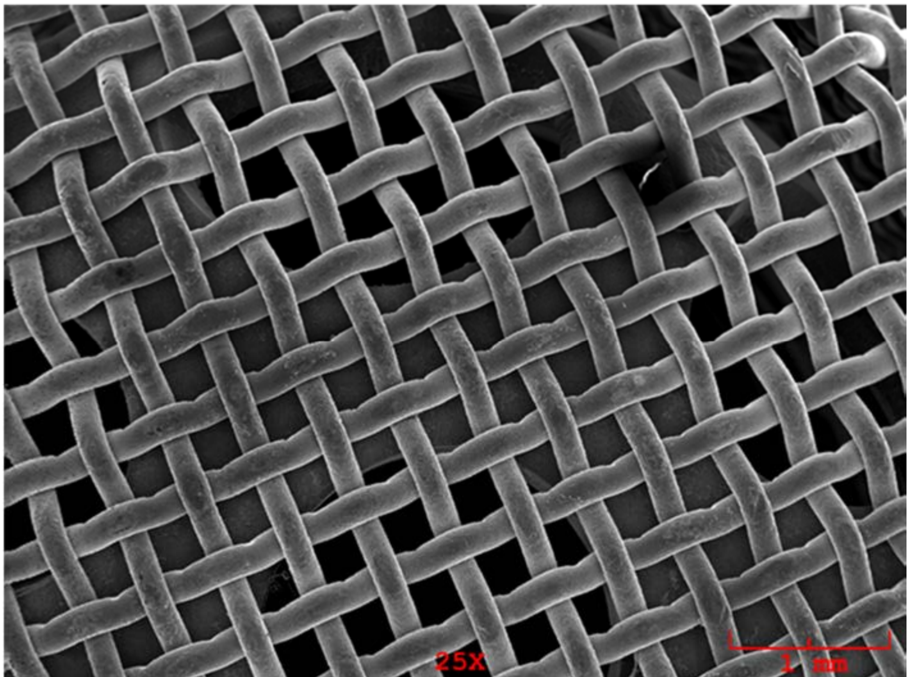


Figure J - 20 F304 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	11.37	7.418	wt.%	0.566	0.545	
O	Ka	8.12	2.064	wt.%	0.192	0.194	
Al	Ka	6.99	1.053	wt.%	0.141	0.178	
Si	Ka	4.03	0.493	wt.%	0.111	0.153	
S	Ka	28.34	2.758	wt.%	0.135	0.133	
Ca	Ka	2.40	0.237	wt.%	0.086	0.124	
Cr	Ka	107.04	14.856	wt.%	0.308	0.171	
Fe	Ka	269.44	60.936	wt.%	0.764	0.273	
Ni	Ka	24.19	8.110	wt.%	0.401	0.348	
Zn	Ka	4.12	2.076	wt.%	0.351	0.436	
			100.000	wt.%			Total

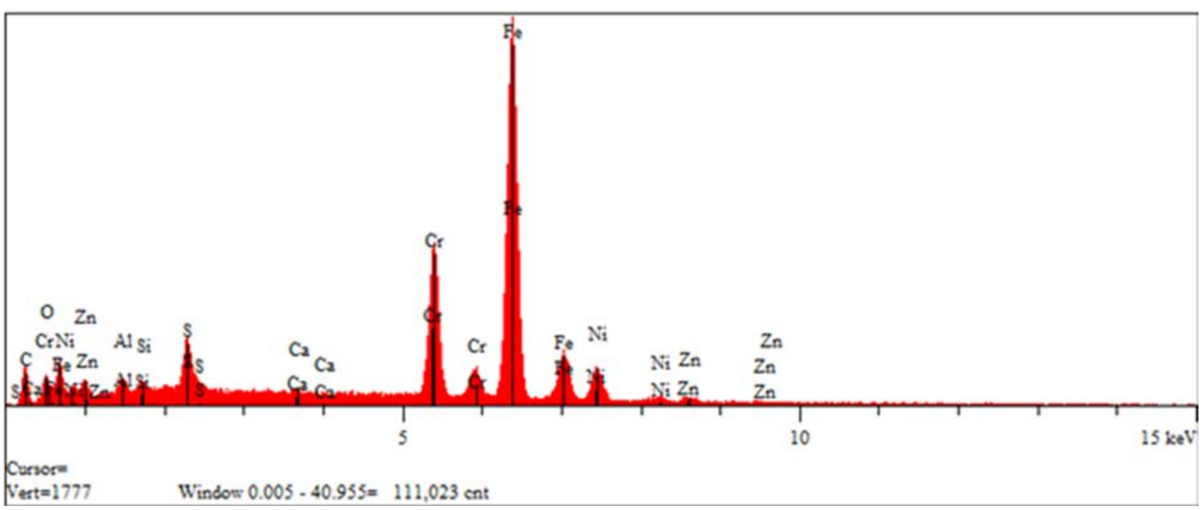


Figure J - 21 F304 Bottom, 25X and EDX Elemental Analysis

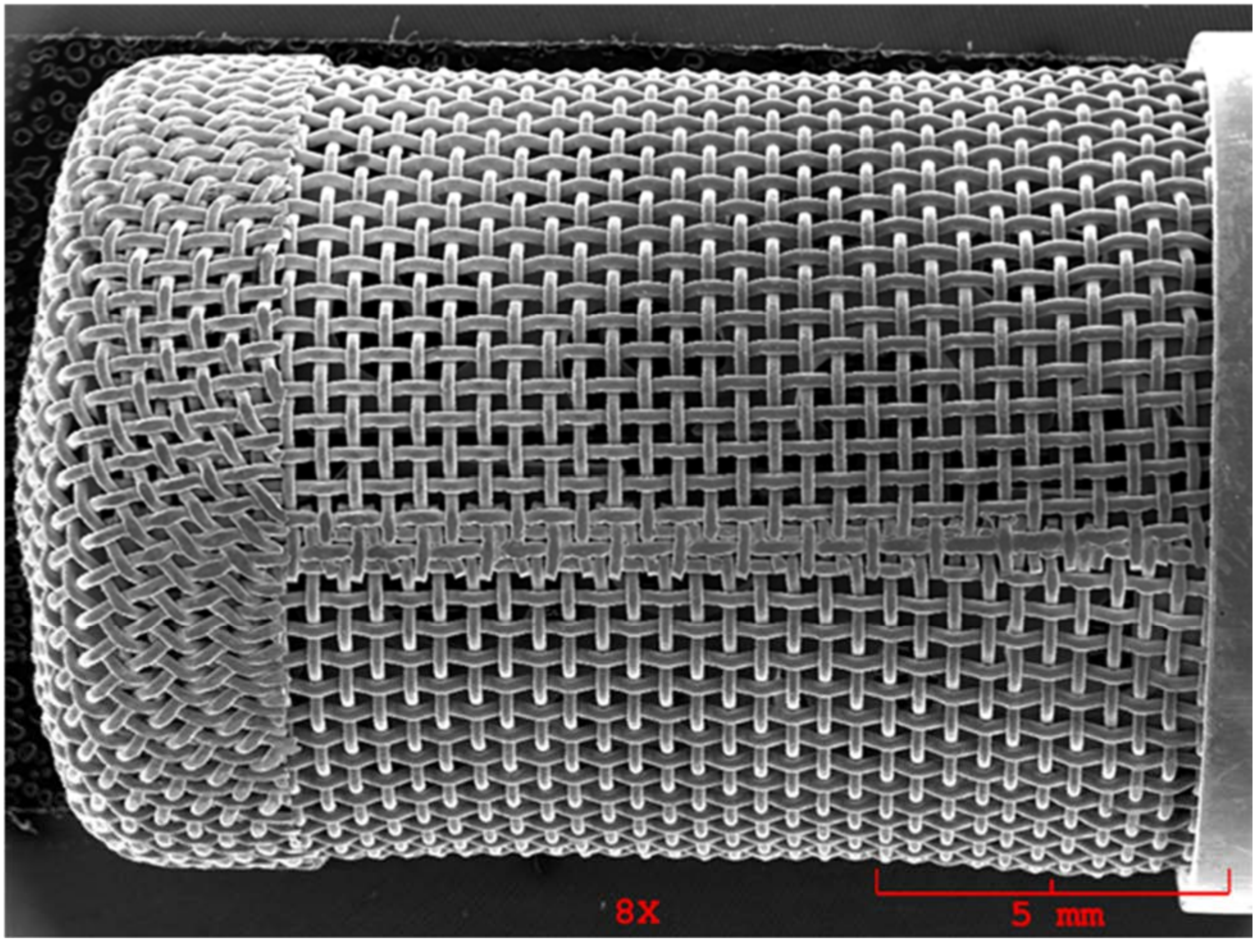
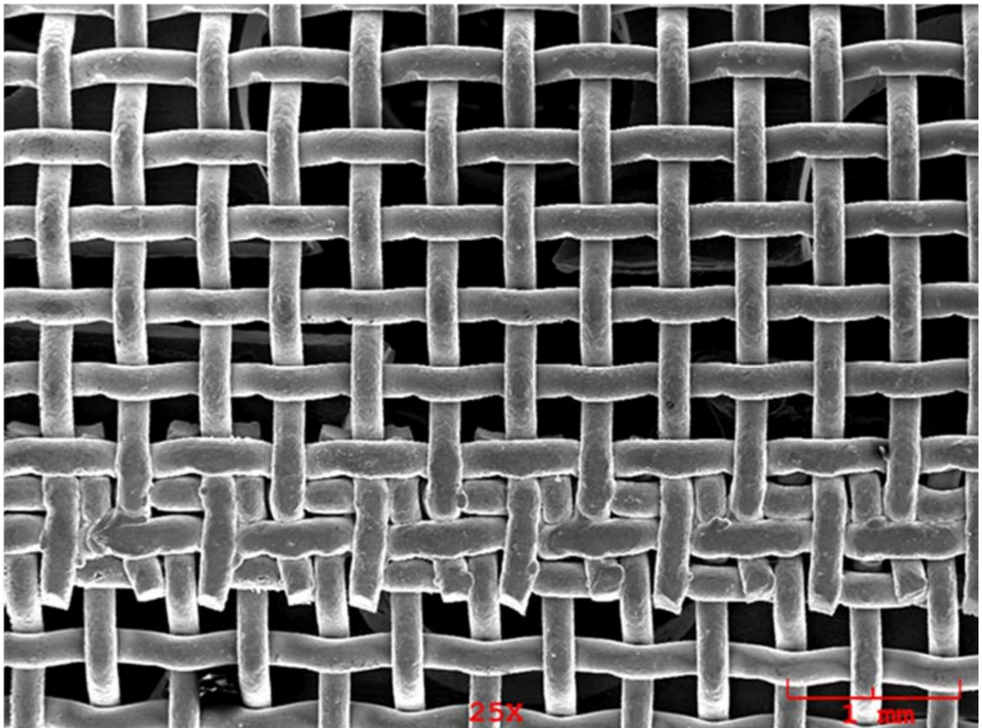


Figure J - 22 F304 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	7.79	4.901	wt.%	0.506	0.557	
O	Ka	6.18	1.441	wt.%	0.165	0.179	
Al	Ka	2.19	0.329	wt.%	0.124	0.178	
Si	Ka	4.13	0.499	wt.%	0.111	0.153	
S	Ka	22.87	2.187	wt.%	0.126	0.133	
Ca	Ka	1.46	0.140	wt.%	0.086	0.126	
Cr	Ka	117.45	15.762	wt.%	0.311	0.168	
Fe	Ka	292.83	64.599	wt.%	0.776	0.276	
Ni	Ka	27.10	8.904	wt.%	0.411	0.349	
Zn	Ka	2.51	1.238	wt.%	0.339	0.460	
			100.000	wt.%			Total

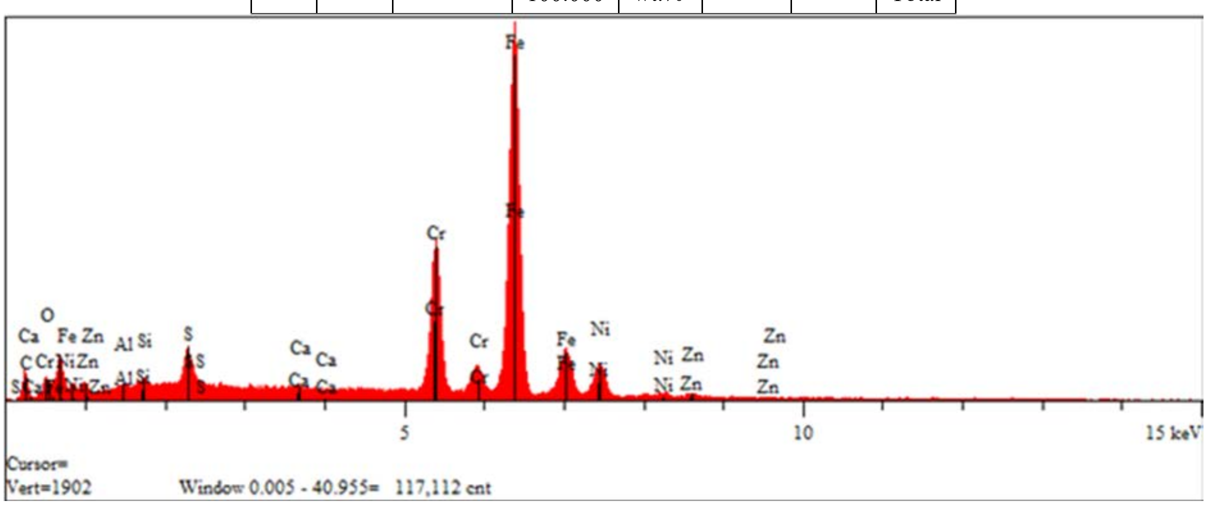


Figure J - 23 F304 Side, 25X and EDX Elemental Analysis

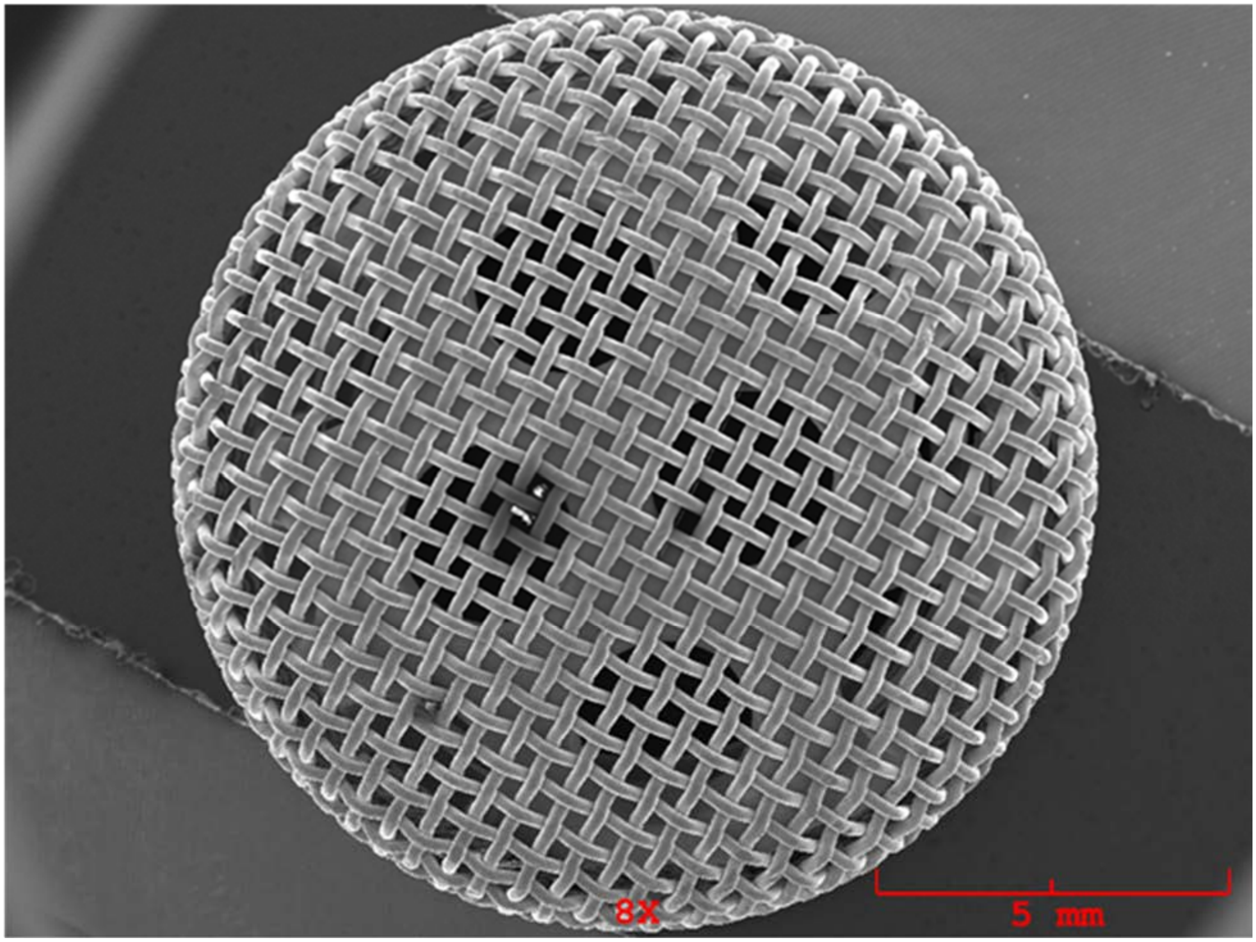
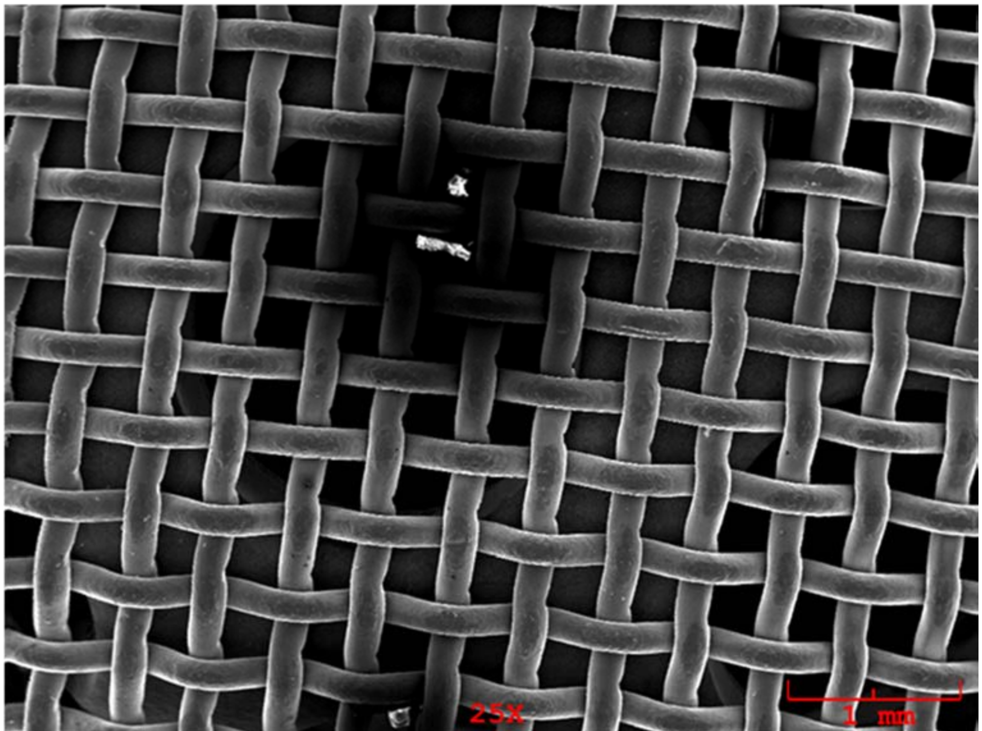


Figure J - 24 F702 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	3.58	2.087	wt.%	0.373	0.460	
O	Ka	2.38	0.485	wt.%	0.119	0.155	
Al	Ka	2.39	0.338	wt.%	0.121	0.173	
Si	Ka	6.27	0.711	wt.%	0.112	0.148	
S	Ka	17.67	1.577	wt.%	0.112	0.127	
Ca	Ka	1.65	0.145	wt.%	0.079	0.116	
Cr	Ka	136.44	16.848	wt.%	0.305	0.152	
Fe	Ka	335.19	68.506	wt.%	0.767	0.260	
Ni	Ka	29.55	9.027	wt.%	0.400	0.340	
Zn	Ka	0.60	0.276	wt.%	0.288	0.428	
			100.000	wt.%			Total

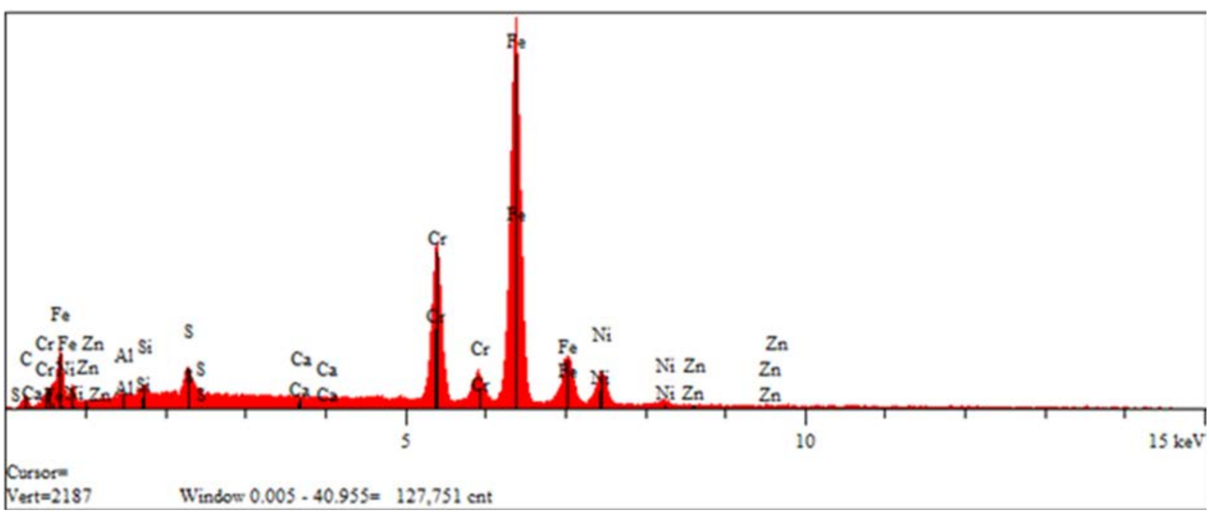


Figure J - 25 F702 Bottom, 25X and EDX Elemental Analysis

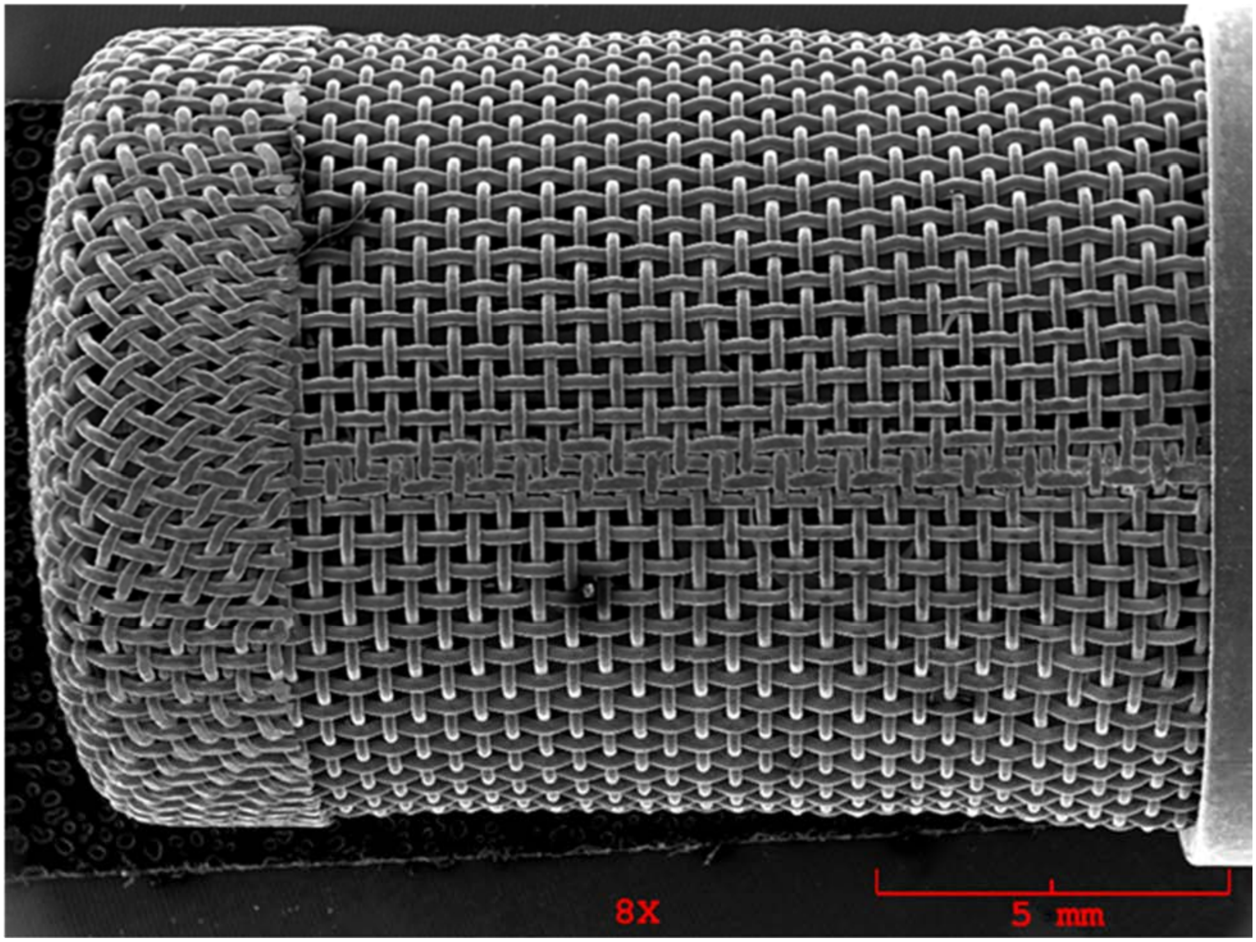
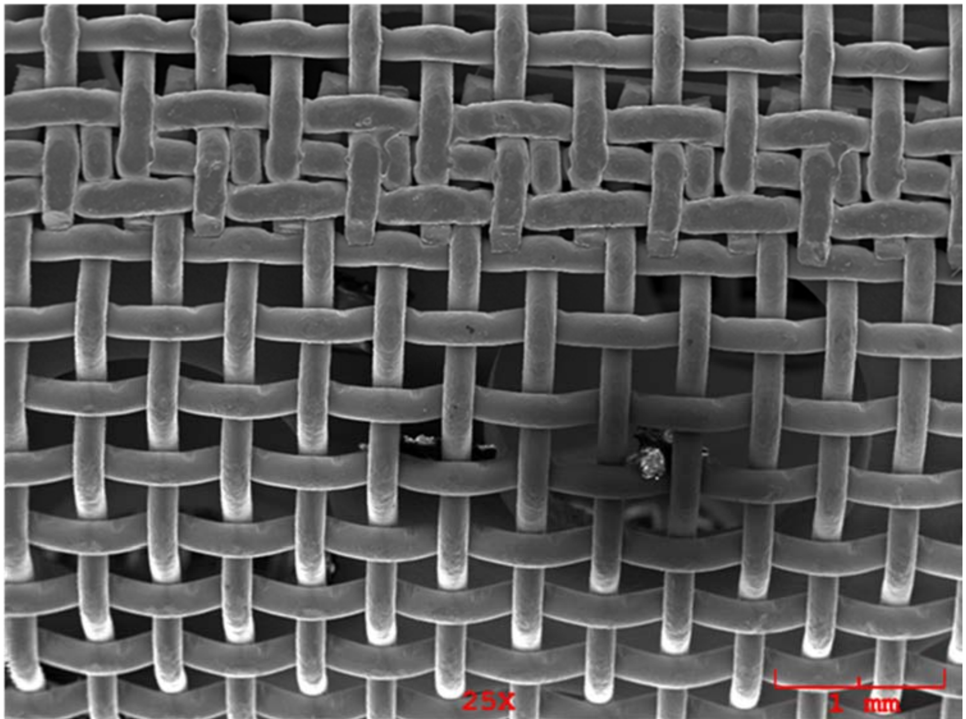


Figure J - 26 F702 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	0.00	0.000	wt.%	0.000	0.000	
O	Ka	2.56	0.532	wt.%	0.829	1.128	
Al	Ka	3.08	0.466	wt.%	0.718	0.996	
Si	Ka	2.13	0.258	wt.%	0.559	0.799	
S	Ka	19.63	1.857	wt.%	0.716	0.818	
Cr	Ka	126.80	16.374	wt.%	1.730	0.769	
Fe	Ka	319.73	68.135	wt.%	4.417	1.268	
Ni	Ka	27.62	8.781	wt.%	2.287	1.944	
Zn	Ka	7.55	3.597	wt.%	1.490	2.236	
			100.000	wt.%			Total

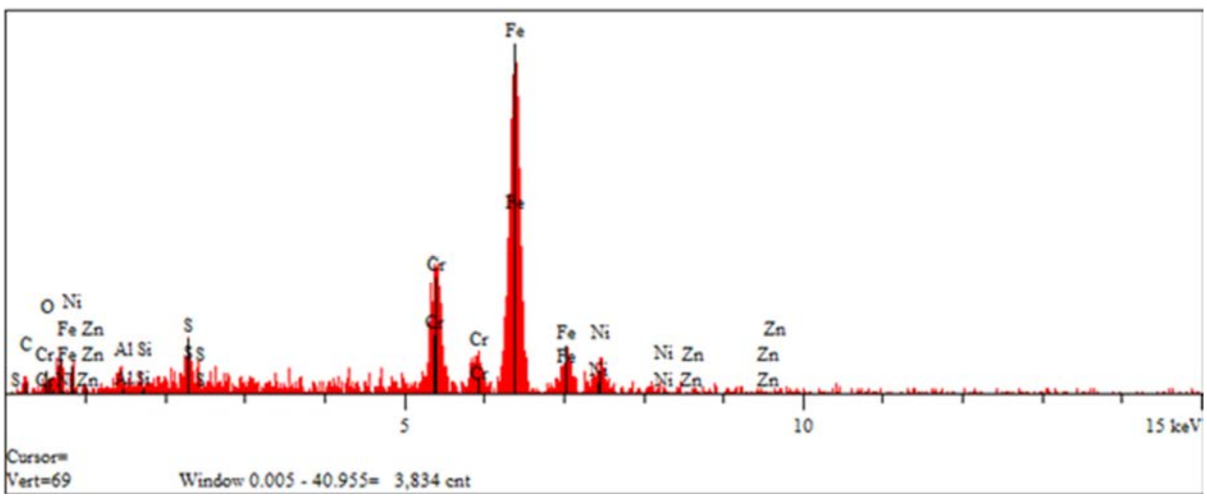


Figure J -27 F702 Side, 25X and EDX Elemental Analysis

APPENDIX K - RUN 155 DATA PACKAGE

Run Conditions: EDTST Mode, MT Conditions
Fuel ID: POSF-12843, Ft McCoy **with 256 mg/L SpecAid 8Q462 (+100)**
Airframe Heat Exchanger Bulk Fuel Output: 285 °F
HP Pump HX Out/FCOC Bulk Fuel In: 325 °F
Fuel-Cooled Oil Cooler Bulk Fuel Output: 350 °F
Burner Feed Arm Max Wetted Wall Temperature: 510 °F
Run Duration: 72 Hours

DATA SUMMARY

Run 155; Run Type: EDTST; Op Mode: MT; MSNs: N/A; EDTST Run Hours: 72 Fuel ID#: POSF12843; Run Tank: Drums; Run Type: EDTST; Op Mode: MT Fuel Type: F-24; Additive(s): GEBetz +100 AFHX Out: 285 °F; FCOC In: 325 °F; FCOC Out: 350 °F; BFA In:

Component/Device	Serial No.	Pre-Test %	Post-Test %	Spread (Pre/Post Delta), %	Shift, PPH	Skew, PSID	Flow Range Shift, PPH	Flow Midpoint Shift, PPH	Overall Rating	Hysteresis Area Change (PPH-DP)
FDV	1136	-12.3	1.2	13.5	0.9	-0.2	0.6	0.3	None	2
Servo2	023	1.9	5.2	3.3	-1.4	-0.5	80.4	40.2	Minor	203

Effective Carbon - µgrams

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	116.5	59.8	54.9	52.6	44.0					
BFA	13.2	17.6	25.3	34.7	42.5	53.1	67.9	69.3	58.5	51.0
Total FCOC Carbon, µgrams	327.8	µgrams	0.3	mgrams						
Total BFA Carbon, µgrams	433.2	µgrams	0.4	mgrams						

SCREENS	Total Carbon, µg	Background Carbon, µg	Effective Carbon, µg	MWWT Start	MWWT End	Delta BFA MWWT	TE	BFA AWWT Start	BFA AWWT End	Delta BFA AWWT
TMS	9.0	0.3	8.7	510.90	509.86	-0.22	MAX	495.93	495.39	-0.54
F303	38.6	25.4	13.2	506.80	505.85	-0.95	TE325	**SV Inlet**	**FDV Inlet**	**BFA Inlet**
F304	39.6	12.9	26.8	510.90	509.86	-1.04	TE324	**(TE702)**	**(TE313)**	**(TE316)**
F305	0.0	0.0	0.0	510.07	509.86	-0.22	TE323	342	328	324
F702	281.2	12.9	268.4	505.29	504.82	-0.47	TE322			

Effective Carbon Deposition - µgrams/cm^2

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	31.9	16.4	15.1	14.4	12.0					
BFA	7.6	10.2	14.7	20.1	24.7	30.9	39.4	40.2	34.0	29.6

TMS Mass Change - grams

Component/Device	Tare, g	Mass, g	Mass Gain, g
TMS	0.08682	0.08685	0.00003
F303	7.14860	7.14878	0.00018
F304	3.05408	3.05375	-0.00033
F305	0.00000	0.00000	0.00000
F702	3.05465	3.05554	0.00089

Hysteresis Ratings:

- NONE: indicating that the pre-test and post-test hysteresis curves, for all intents and purposes, are nearly indistinguishable from one another. Minor differences may be seen between the pre-test and post-test curves but these are very small.
- Minor: There are small differences between per- and post-test curves. The spread for these curves is typically within 5% of one another. There may be some small changes in shift and skew for the valve. This degree of hysteresis would not be expected to alter the functional nature of the valve.
- Moderate: There are definite differences between pre-and post-test curves. There may be definite differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically between 5% and 15%. This degree of hysteresis might be expected to alter the functional nature of the valve.
- Severe: There are pronounce differences between pre-and post-test curves. There may be pronounced differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically in excess 15%. This degree of hysteresis would be considered out-of-spec for the valve.
- Non-Functional: There are major differences between pre-and post-test curves. There may be major differences in shift and skew as well. The hysteresis curve will exhibit flat segments (either vertically or horizontally). Shift and skew have majorly changed the performance envelope of the valve. This degree of hysteresis would cause the valve to be non-functional or unresponsive over small or large portions of the performance range of the valve.

Figure K - 1 Run 155 Data Summary

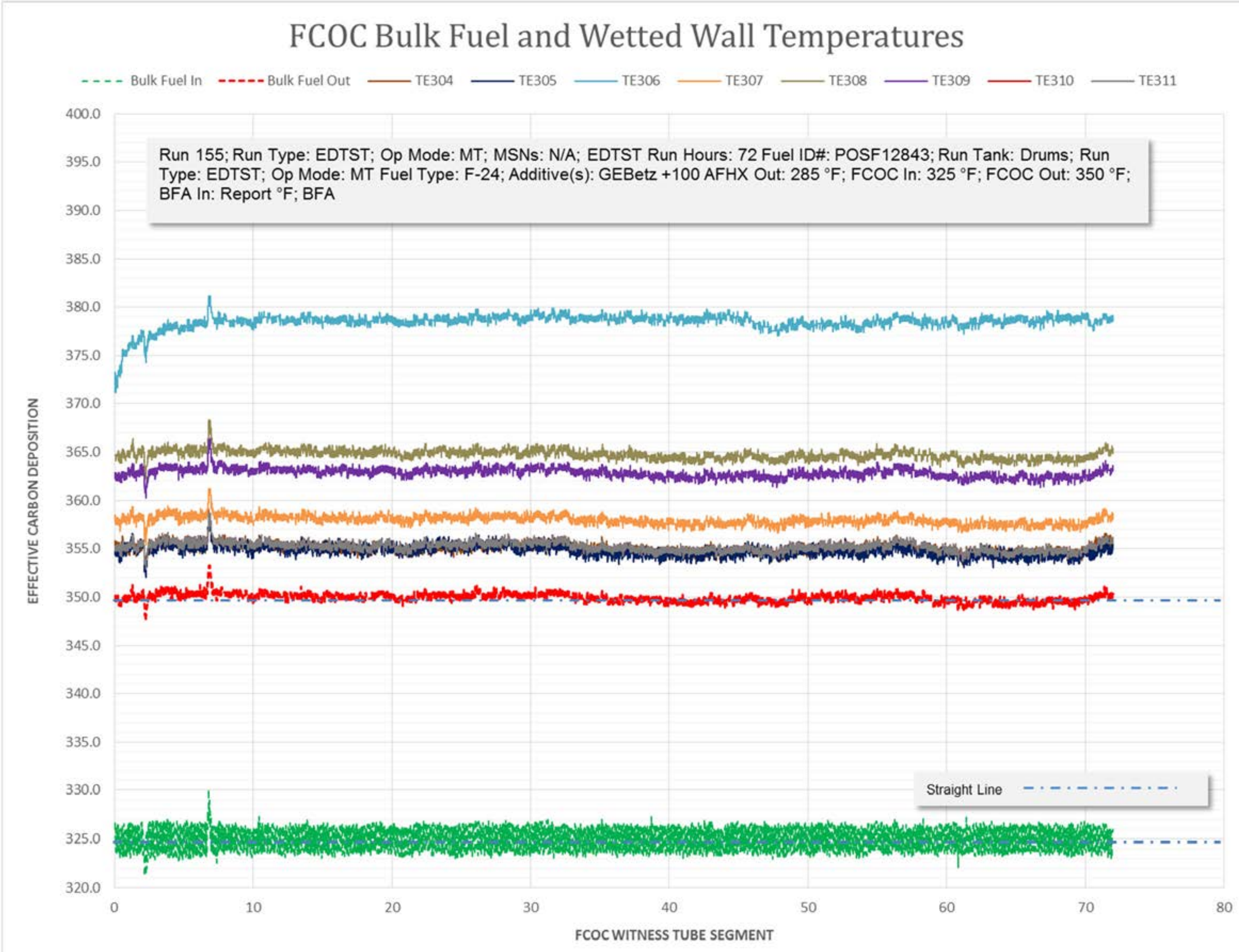


Figure K - 2 FCOC Bulk Fuel and Wetted Wall Temperatures

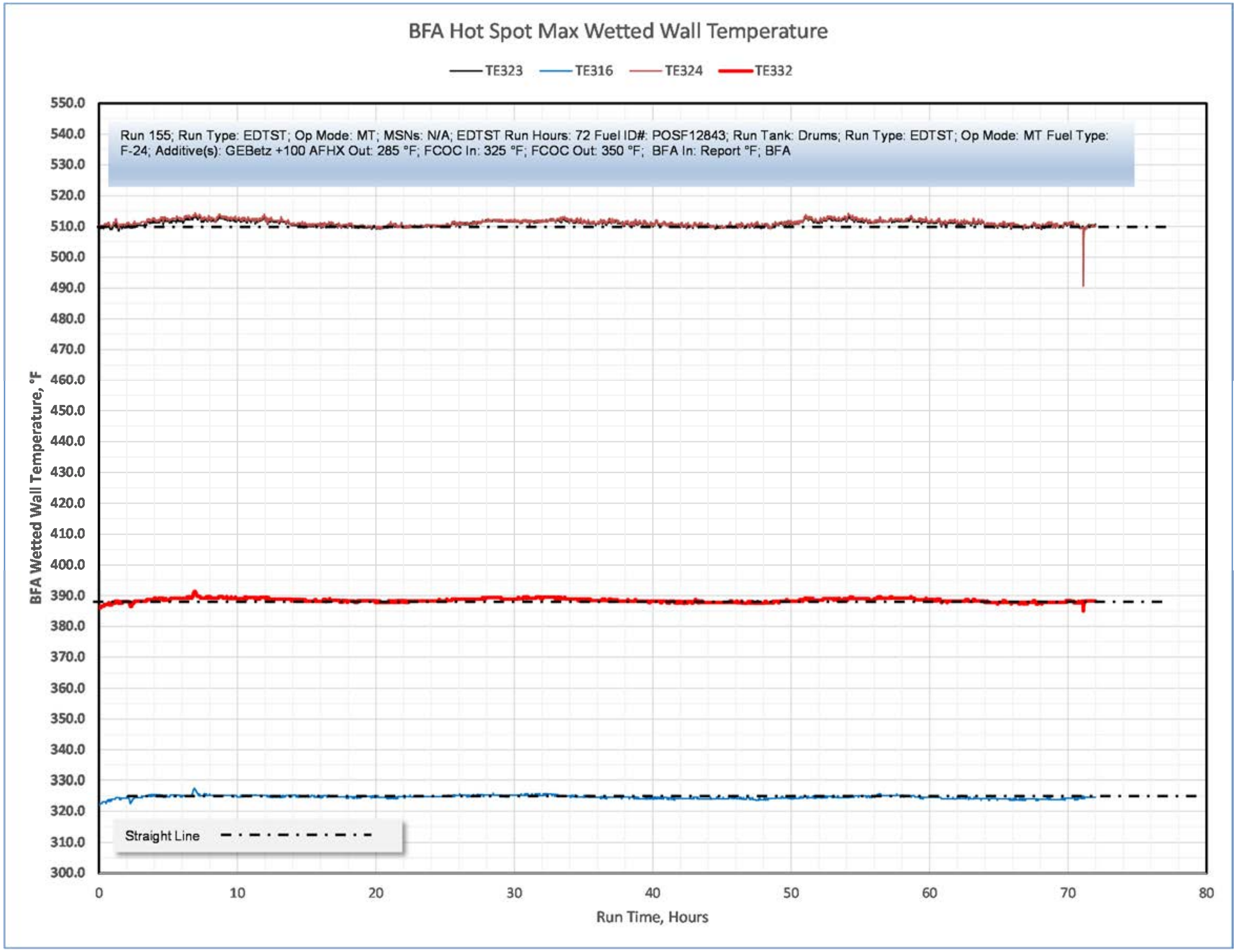


Figure K - 3 BFA Hot Spot Max Wetted Wall And Bulk Fuel Temperatures

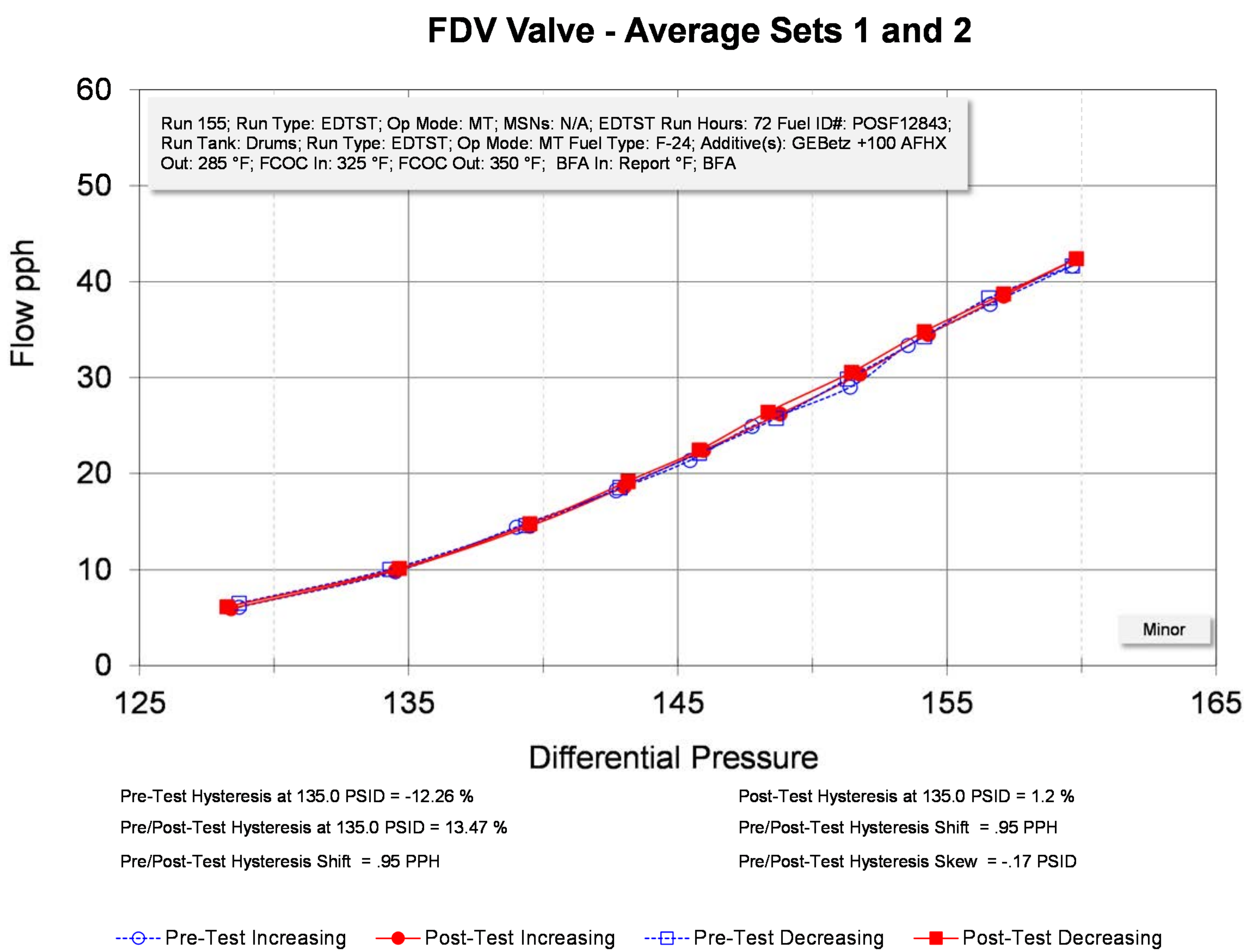


Figure K - 4 FDV Hysteresis

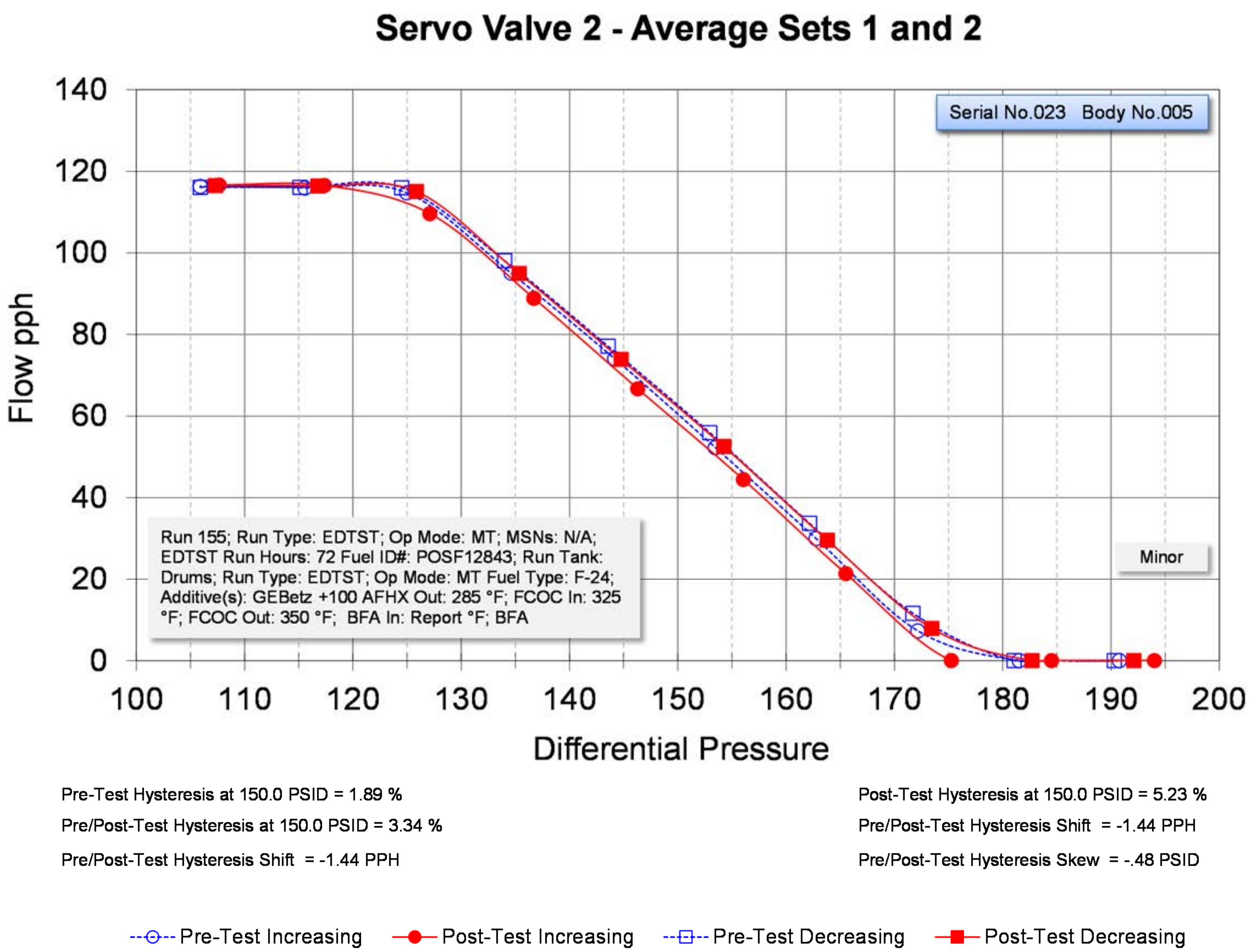


Figure K - 5 Servo Valve Hysteresis

FDV Components Comparison to Clean
Run 155

Figure K - 6 FDV Components - Comparison to Clean

Servo Valve and Nozzle Screen Simulator Components – Comparison To Clean - Run 155

Run 155 | Clean

Run 155 POSF-12843 +100 MT

Figure K - 7 Servo Valve and Nozzle Screen Components - Comparison to Clean

TMS Screens Comparison to Clean - Run 155

Figure K - 8 TMS Screen Top and Bottom - Comparison to Clean

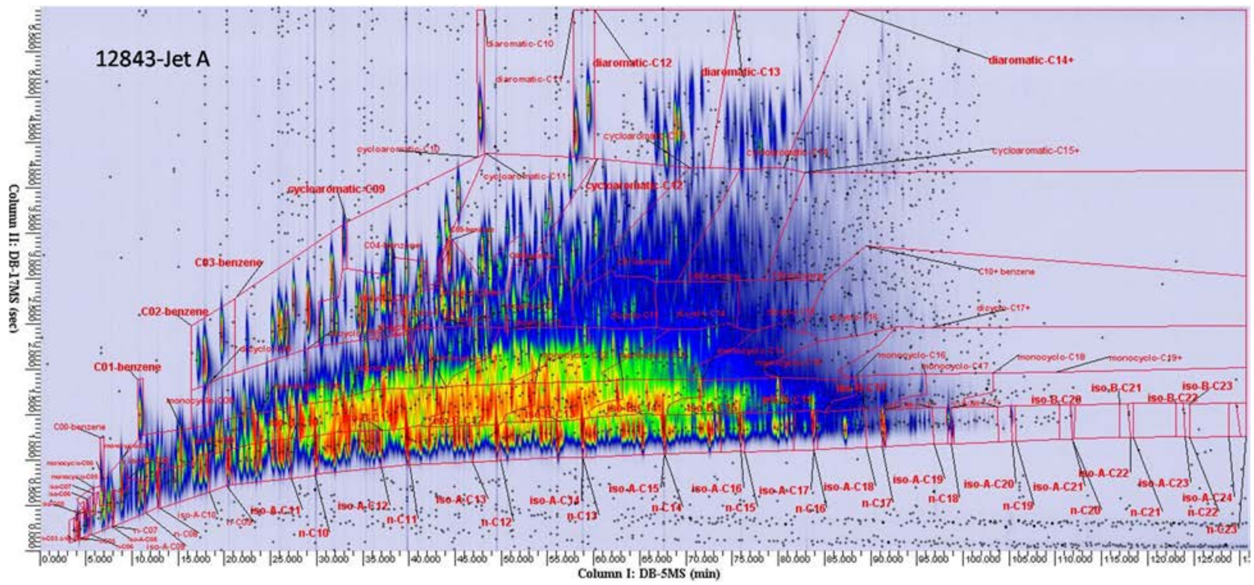


Figure K - 9 GCxGC Summary POSF-12843 Neat Fuel

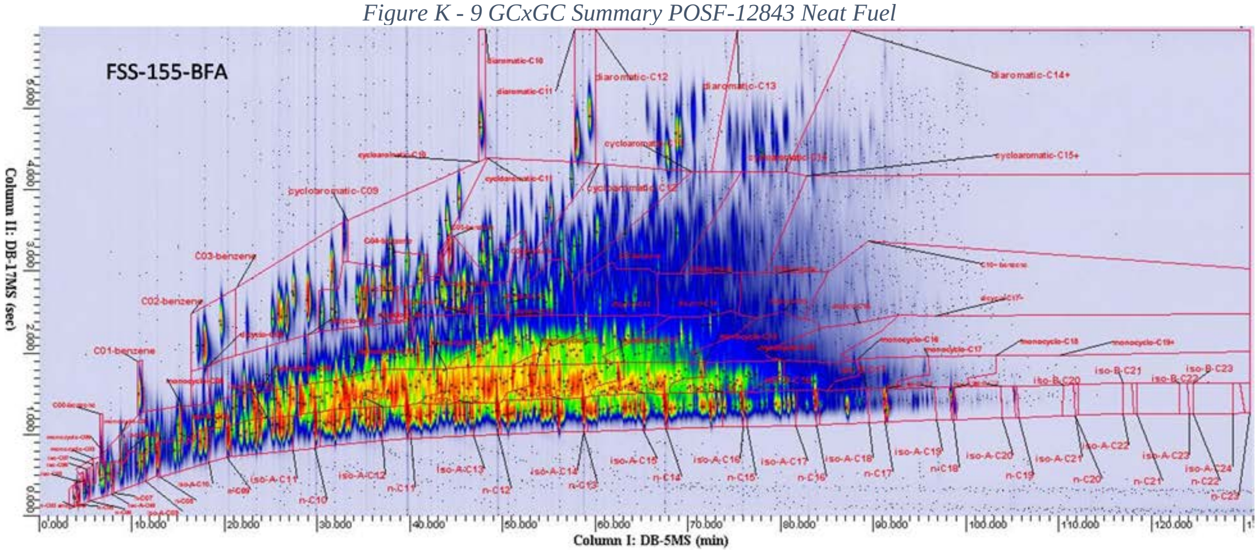


Figure K - 10 GCxGC Summary POSF-12843 Run 155 BFA Outlet

Table K - 4 GCxGC Tabulated Data POSF-12843 Jet A Neat and Run 155 BFA Outlet

GCxGC Summary				
Hydrogen content (weight %)	13.9		13.9	
Average Molecular Wt (g/mole)	163		163	
	POSF-12843- Jet A		12899-FSS155-BFA	
	Weight %	Volume %	Weight %	Volume %
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	<0.01	<0.01
toluene (C07)	0.12	0.11	0.11	0.10
C2-benzene (C08)	0.56	0.52	0.55	0.51
C3-benzene (C09)	1.90	1.77	1.88	1.74
C4-benzene (C10)	2.45	2.29	2.45	2.28
C5-benzene (C11)	1.86	1.72	1.87	1.74
C6-benzene (C12)	1.62	1.51	1.61	1.49
C7-benzene (C13)	1.00	0.93	0.98	0.91
C8-benzene (C14)	0.83	0.77	0.76	0.71
C9-benzene (C15)	0.59	0.55	0.55	0.51
C10+-benzene (C16+)	0.40	0.37	0.38	0.35
Total Alkylbenzenes	**11.35**	10.56	**11.14**	10.36
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.10	0.08
diaromatic-C11	0.42	0.33	0.41	0.32
diaromatic-C12	0.73	0.58	0.71	0.57
diaromatic-C13	0.51	0.42	0.50	0.41
diaromatic-C14+	0.31	0.26	0.27	0.23
Total Alkylnaphthalenes	**2.08**	1.67	**2.00**	1.60
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.04	0.04	0.04	0.04
cycloaromatic-C10	0.37	0.30	0.35	0.29
cycloaromatic-C11	0.87	0.75	0.88	0.75
cycloaromatic-C12	1.16	1.01	1.19	1.04
cycloaromatic-C13	1.47	1.29	1.42	1.24
cycloaromatic-C14	0.83	0.73	0.85	0.75
cycloaromatics-C15+	0.41	0.36	0.44	0.39
Total Cycloaromatics	**5.16**	4.47	**5.18**	4.49
Total Aromatics	**18.59**	**16.70**	**18.32**	**16.44**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.22	0.27	0.22	0.27
C08-isoparaffins	0.44	0.50	0.43	0.49
C09-isoparaffins	0.84	0.94	0.80	0.90
C10-isoparaffins	3.27	3.60	3.29	3.63
C11-isoparaffins	4.25	4.59	4.39	4.73
C12-isoparaffins	3.56	3.85	3.60	3.90
C13-isoparaffins	3.40	3.59	3.44	3.63
C14-isoparaffins	3.18	3.34	3.21	3.37
C15-isoparaffins	2.29	2.39	2.33	2.42
C16-isoparaffins	1.06	1.10	1.06	1.10
C17-isoparaffins	0.56	0.58	0.51	0.53
C18-isoparaffins	0.15	0.15	0.14	0.15
C19-isoparaffins	0.08	0.08	0.08	0.08
C20-isoparaffins	0.03	0.03	0.03	0.03
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01
Total iso-Paraffins	**23.31**	25.01	**23.54**	25.23

n-Paraffins				
n-C07 & lower	0.17	0.20	0.17	0.20
n-C08	0.43	0.49	0.42	0.47
n-C09	1.01	1.13	1.00	1.11
n-C10	2.54	2.79	2.51	2.75
n-C11	3.01	3.26	3.01	3.25
n-C12	2.52	2.70	2.56	2.74
n-C13	2.00	2.12	2.02	2.14
n-C14	1.54	1.62	1.54	1.62
n-C15	0.89	0.93	0.87	0.90
n-C16	0.43	0.44	0.42	0.44
n-C17	0.20	0.20	0.20	0.20
n-C18	0.04	0.04	0.04	0.04
n-C19	<0.01	<0.01	<0.01	<0.01
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**14.80**	15.93	**14.76**	15.87
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.42	0.43	0.41	0.43
C08-monocyclocycloparaffins	0.63	0.64	0.62	0.63
C09-monocyclocycloparaffins	1.82	1.84	1.86	1.88
C10-monocyclocycloparaffins	4.60	4.50	4.44	4.34
C11-monocyclocycloparaffins	6.32	6.36	6.82	6.85
C12-monocyclocycloparaffins	5.57	5.57	5.58	5.57
C13-monocyclocycloparaffins	5.07	5.02	5.09	5.02
C14-monocyclocycloparaffins	3.15	3.12	3.30	3.27
C15-monocyclocycloparaffins	2.10	2.07	2.10	2.07
C16-monocyclocycloparaffins	0.86	0.85	1.05	1.03
C17-monocyclocycloparaffins	0.33	0.32	0.39	0.39
C18-monocyclocycloparaffins	0.05	0.05	0.05	0.04
C19+-monocyclocycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Monocycloparaffins	**30.93**	30.78	**31.72**	31.54
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.45	0.42	0.46	0.42
C10-dicycloparaffins	1.01	0.90	1.02	0.91
C11-dicycloparaffins	2.32	2.17	1.89	1.77
C12-dicycloparaffins	2.69	2.54	2.48	2.34
C13-dicycloparaffins	3.00	2.83	3.32	3.13
C14-dicycloparaffins	1.94	1.83	1.63	1.54
C15-dicycloparaffins	0.60	0.56	0.63	0.59
C16-dicycloparaffins	0.21	0.20	0.09	0.09
C17+-dicycloparaffins	0.04	0.03	0.02	0.02
Total Dicycloparaffins	**12.27**	11.51	**11.57**	10.84
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.09	0.07	0.09	0.08
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.09**	0.08	**0.09**	0.08
Total Cycloparaffins	**43.29**	42.36	**43.38**	42.45
Average Molecular Formula - C	11.7		11.7	
Average Molecular Formula - H	22.4		22.4	

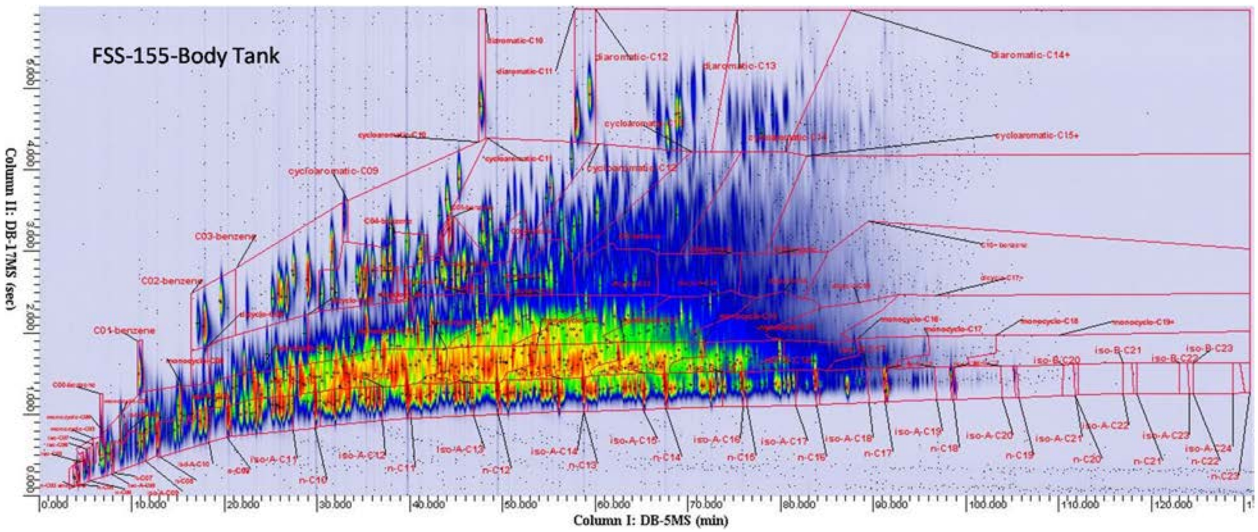


Figure K - 11 GCxGC Summary Fuel From Body Tank

Table K - 2 GCxGC Tabulated Data - Fuel From Body Tank at the End Of Run

GCxGC Summary				
Hydrogen content (weight %)	13.9		13.9	
Average Molecular Wt (g/mole)	163		163	
	POSF-12843- Jet A		12899-FSS155-Body Tank	
	Weight %	Volume %	Weight %	Volume %
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	<0.01	<0.01
toluene (C07)	0.12	0.11	0.11	0.10
C2-benzene (C08)	0.56	0.52	0.55	0.51
C3-benzene (C09)	1.90	1.77	1.88	1.74
C4-benzene (C10)	2.45	2.29	2.45	2.28
C5-benzene (C11)	1.86	1.72	1.87	1.74
C6-benzene (C12)	1.62	1.51	1.61	1.50
C7-benzene (C13)	1.00	0.93	0.97	0.91
C8-benzene (C14)	0.83	0.77	0.75	0.70
C9-benzene (C15)	0.59	0.55	0.55	0.52
C10+-benzene (C16+)	0.40	0.37	0.37	0.34
Total Alkylbenzenes	**11.35**	10.56	**11.12**	10.34
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.10	0.08
diaromatic-C11	0.42	0.33	0.41	0.32
diaromatic-C12	0.73	0.58	0.71	0.57
diaromatic-C13	0.51	0.42	0.50	0.40
diaromatic-C14+	0.31	0.26	0.29	0.24
Total Alkylnaphthalenes	**2.08**	1.67	**2.01**	1.62
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.04	0.04	0.04	0.04
cycloaromatic-C10	0.37	0.30	0.35	0.29
cycloaromatic-C11	0.87	0.75	0.87	0.74
cycloaromatic-C12	1.16	1.01	1.17	1.02
cycloaromatic-C13	1.47	1.29	1.46	1.27
cycloaromatic-C14	0.83	0.73	0.85	0.74
cycloaromatics-C15+	0.41	0.36	0.40	0.35
Total Cycloaromatics	**5.16**	4.47	**5.14**	4.45
Total Aromatics	**18.59**	**16.70**	**18.28**	**16.41**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.22	0.27	0.22	0.26
C08-isoparaffins	0.44	0.50	0.42	0.49
C09-isoparaffins	0.84	0.94	0.78	0.88
C10-isoparaffins	3.27	3.60	3.34	3.69
C11-isoparaffins	4.25	4.59	4.44	4.79
C12-isoparaffins	3.56	3.85	3.55	3.84
C13-isoparaffins	3.40	3.59	3.44	3.64
C14-isoparaffins	3.18	3.34	3.20	3.35
C15-isoparaffins	2.29	2.39	2.33	2.43
C16-isoparaffins	1.06	1.10	1.04	1.08
C17-isoparaffins	0.56	0.58	0.58	0.59
C18-isoparaffins	0.15	0.15	0.14	0.14
C19-isoparaffins	0.08	0.08	0.08	0.08
C20-isoparaffins	0.03	0.03	0.03	0.03
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01
Total iso-Paraffins	**23.31**	25.01	**23.59**	25.29

n-Paraffins				
n-C07 & lower	0.17	0.20	0.16	0.19
n-C08	0.43	0.49	0.41	0.47
n-C09	1.01	1.13	1.00	1.11
n-C10	2.54	2.79	2.50	2.74
n-C11	3.01	3.26	3.01	3.26
n-C12	2.52	2.70	2.55	2.72
n-C13	2.00	2.12	2.02	2.14
n-C14	1.54	1.62	1.55	1.63
n-C15	0.89	0.93	0.90	0.93
n-C16	0.43	0.44	0.42	0.44
n-C17	0.20	0.20	0.19	0.20
n-C18	0.04	0.04	0.04	0.04
n-C19	<0.01	<0.01	<0.01	<0.01
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**14.80**	15.93	**14.78**	15.89
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.42	0.43	0.41	0.43
C08-monocyclocycloparaffins	0.63	0.64	0.60	0.61
C09-monocyclocycloparaffins	1.82	1.84	1.80	1.81
C10-monocyclocycloparaffins	4.60	4.50	4.54	4.44
C11-monocyclocycloparaffins	6.32	6.36	6.39	6.42
C12-monocyclocycloparaffins	5.57	5.57	5.71	5.70
C13-monocyclocycloparaffins	5.07	5.02	5.24	5.18
C14-monocyclocycloparaffins	3.15	3.12	3.23	3.20
C15-monocyclocycloparaffins	2.10	2.07	2.09	2.07
C16-monocyclocycloparaffins	0.86	0.85	0.89	0.88
C17-monocyclocycloparaffins	0.33	0.32	0.37	0.36
C18-monocyclocycloparaffins	0.05	0.05	0.05	0.05
C19+-monocyclocycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Monocycloparaffins	**30.93**	30.78	**31.33**	31.16
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.45	0.42	0.47	0.43
C10-dicycloparaffins	1.01	0.90	1.00	0.89
C11-dicycloparaffins	2.32	2.17	2.12	1.99
C12-dicycloparaffins	2.69	2.54	2.59	2.44
C13-dicycloparaffins	3.00	2.83	2.95	2.78
C14-dicycloparaffins	1.94	1.83	1.94	1.83
C15-dicycloparaffins	0.60	0.56	0.57	0.54
C16-dicycloparaffins	0.21	0.20	0.24	0.22
C17+-dicycloparaffins	0.04	0.03	0.03	0.03
Total Dicycloparaffins	**12.27**	11.51	**11.93**	11.18
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.09	0.07	0.09	0.08
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.09**	0.08	**0.09**	0.08
Total Cycloparaffins	**43.29**	42.36	**43.35**	42.41
Average Molecular Formula - C	11.7		11.7	
Average Molecular Formula - H	22.4		22.5	

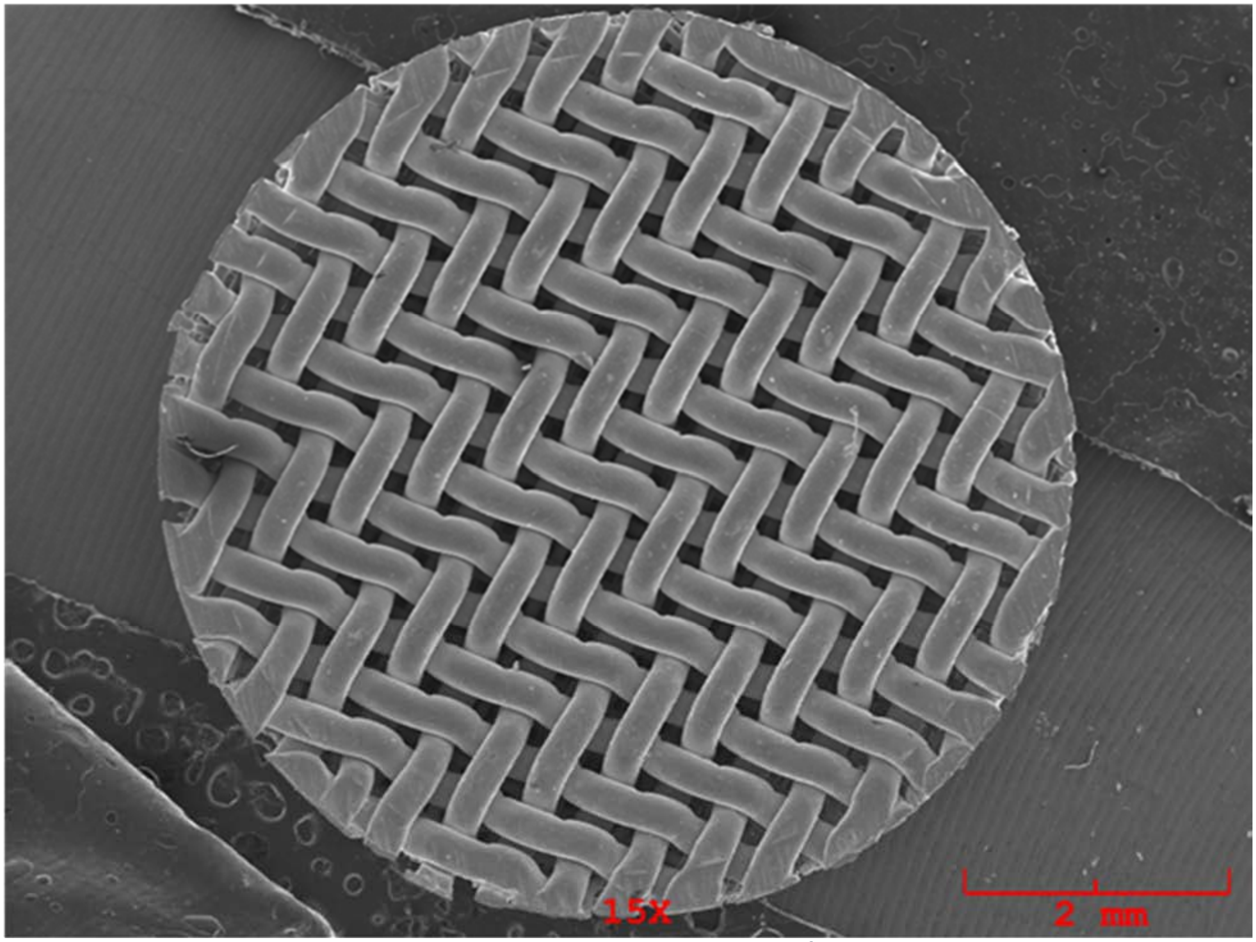
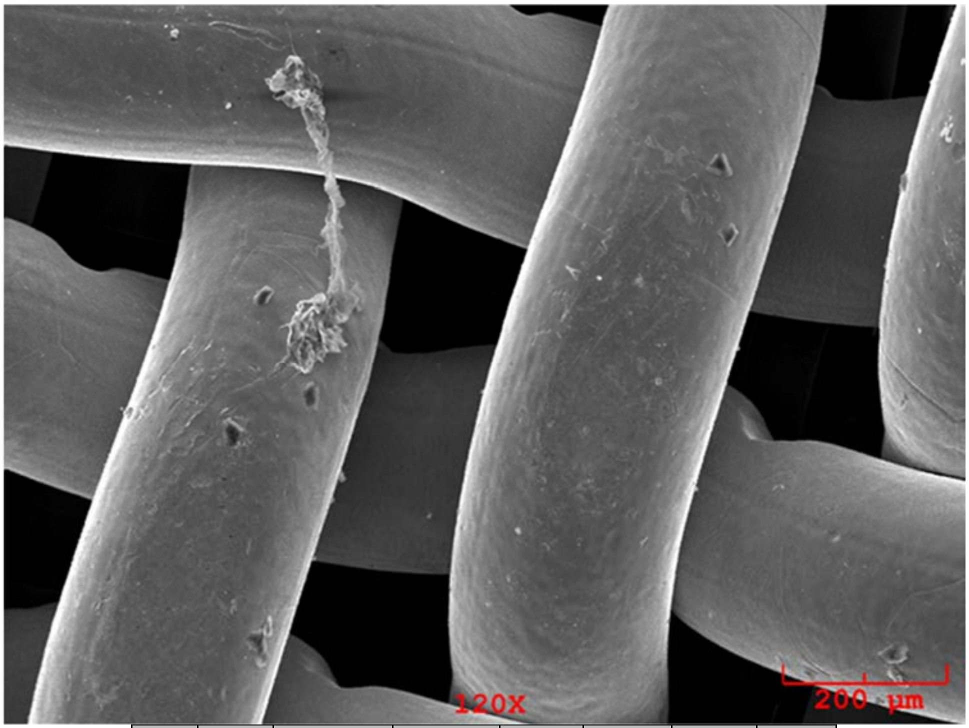


Figure K - 12 TMS Screen, Top, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	3.61	1.751	wt.%	0.300	0.362	
O	Ka	0.00	0.000	wt.%	0.000	0.000	
Al	Ka	5.92	0.729	wt.%	0.118	0.156	
Si	Ka	5.03	0.500	wt.%	0.098	0.133	
S	Ka	4.07	0.316	wt.%	0.082	0.116	
Cr	Ka	165.59	17.594	wt.%	0.293	0.161	
Fe	Ka	392.28	69.205	wt.%	0.718	0.255	
Ni	Ka	34.44	9.092	wt.%	0.379	0.335	
Cu	Ka	2.50	0.813	wt.%	0.252	0.352	
			100.000	wt.%			Total

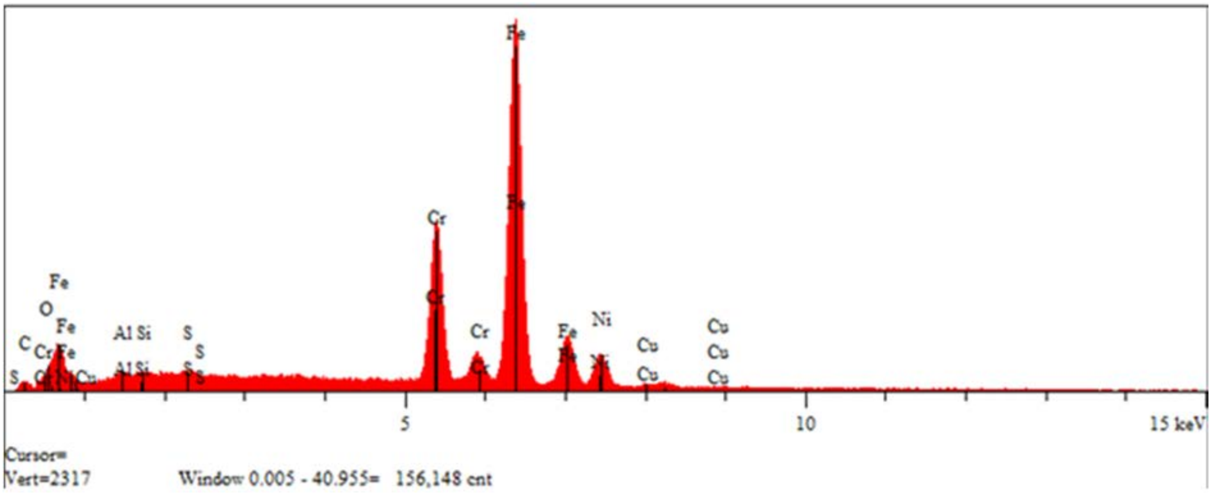


Figure K - 13 TMS Screen Top, 120X and EDX Elemental Analysis

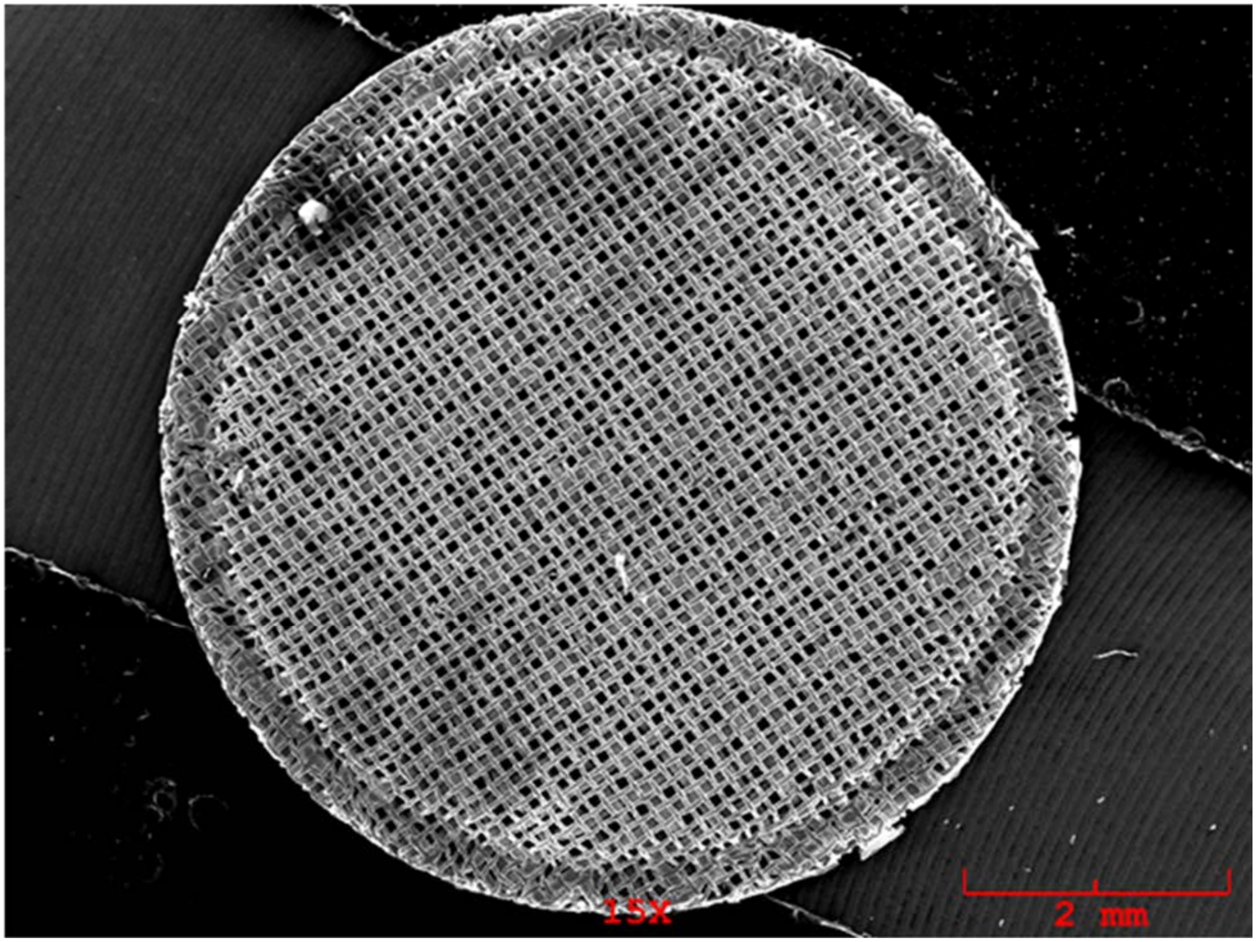
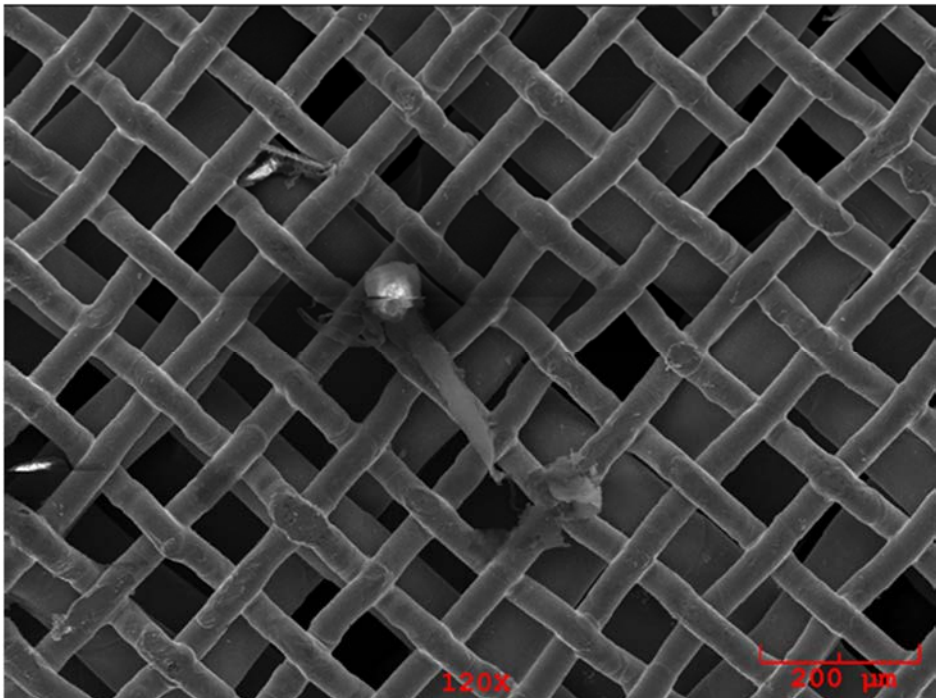


Figure K - 14 TMS Screen, Bottom, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	3.66	2.170	wt.%	0.440	0.578	
O	Ka	0.00	0.000	wt.%	0.000	0.000	
F	Ka	1.85	0.438	wt.%	0.148	0.205	
Al	Ka	4.31	0.647	wt.%	0.133	0.180	
Si	Ka	3.07	0.371	wt.%	0.108	0.153	
S	Ka	6.90	0.653	wt.%	0.099	0.132	
Cr	Ka	141.50	18.615	wt.%	0.334	0.179	
Fe	Ka	315.80	68.735	wt.%	0.796	0.285	
Ni	Ka	23.81	7.730	wt.%	0.385	0.336	
Cu	Ka	1.60	0.642	wt.%	0.270	0.382	
			100.000	wt.%			Total

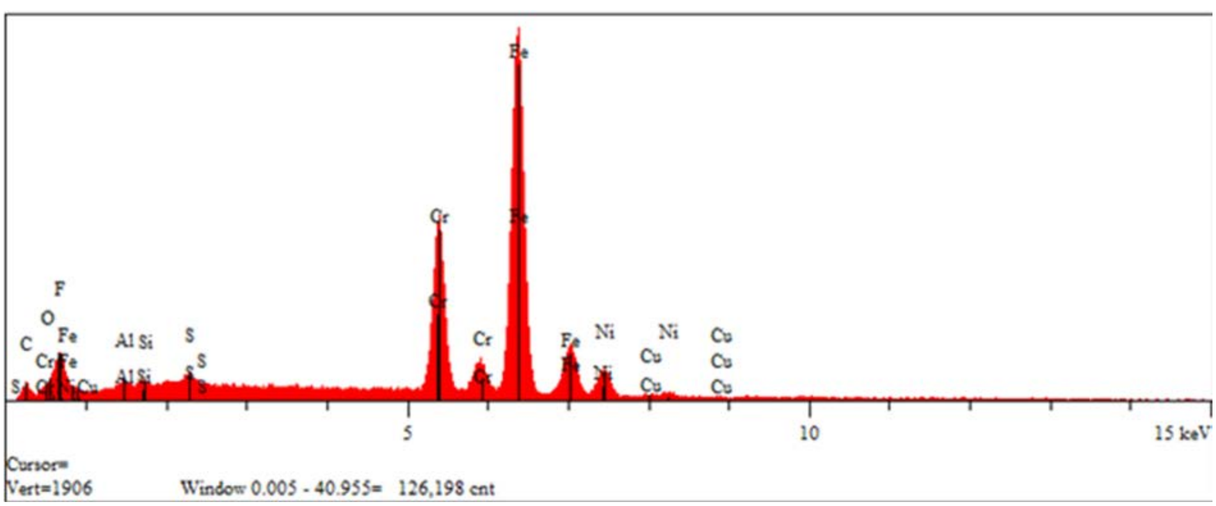


Figure K - 15 TMS Screen, Bottom, 120X and EDX Elemental Analysis

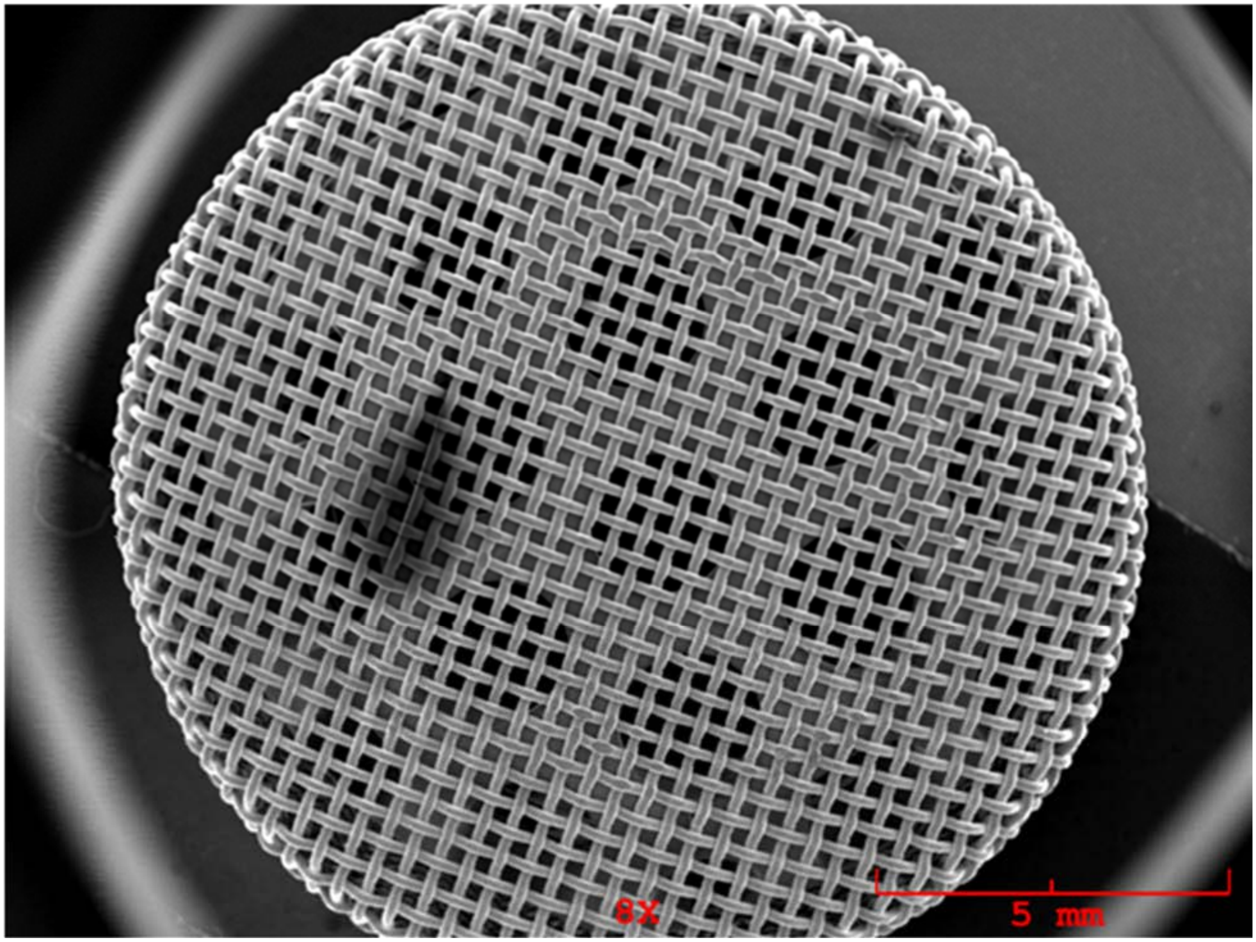
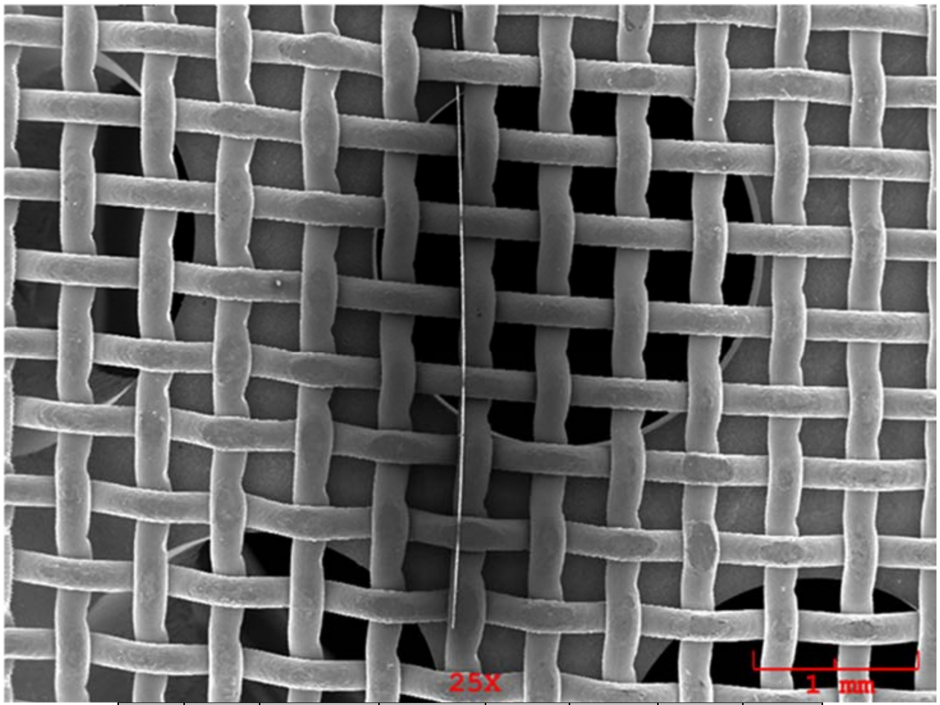


Figure K - 16 F303 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	0.45	0.354	wt.%	0.383	0.563	
O	Ka	0.00	0.000	wt.%	0.000	0.000	
Al	Ka	0.51	0.101	wt.%	0.146	0.219	
Si	Ka	3.24	0.506	wt.%	0.135	0.188	
S	Ka	7.56	0.923	wt.%	0.123	0.158	
Cr	Ka	100.38	16.615	wt.%	0.356	0.197	
Fe	Ka	256.10	70.717	wt.%	0.910	0.335	
Ni	Ka	24.30	10.075	wt.%	0.495	0.428	
Cu	Ka	1.39	0.710	wt.%	0.318	0.451	
			100.000	wt.%			Total

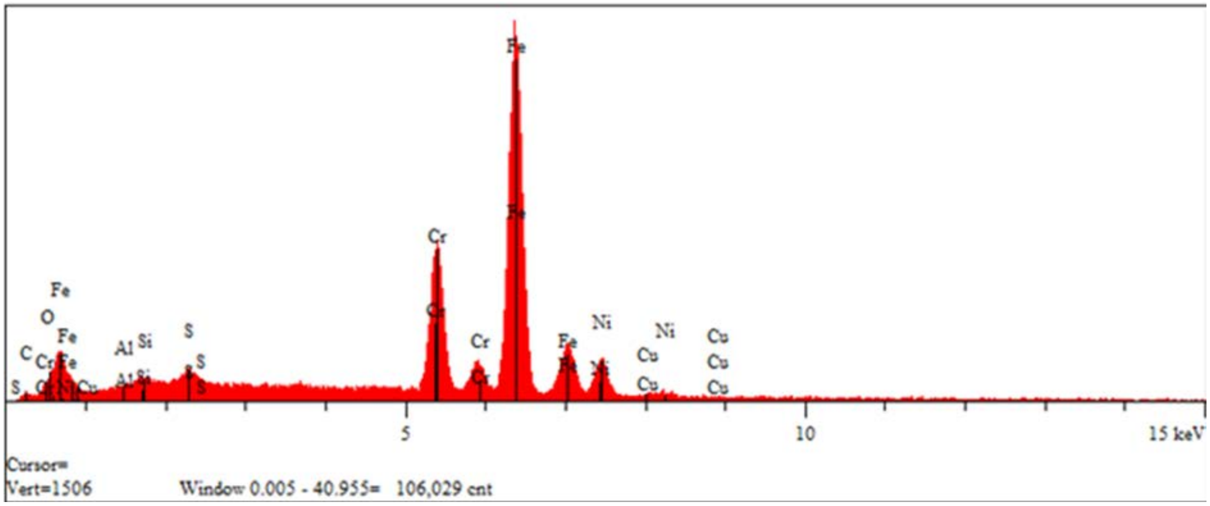


Figure K - 17 F303 Bottom 25X and EDX Elemental Analysis

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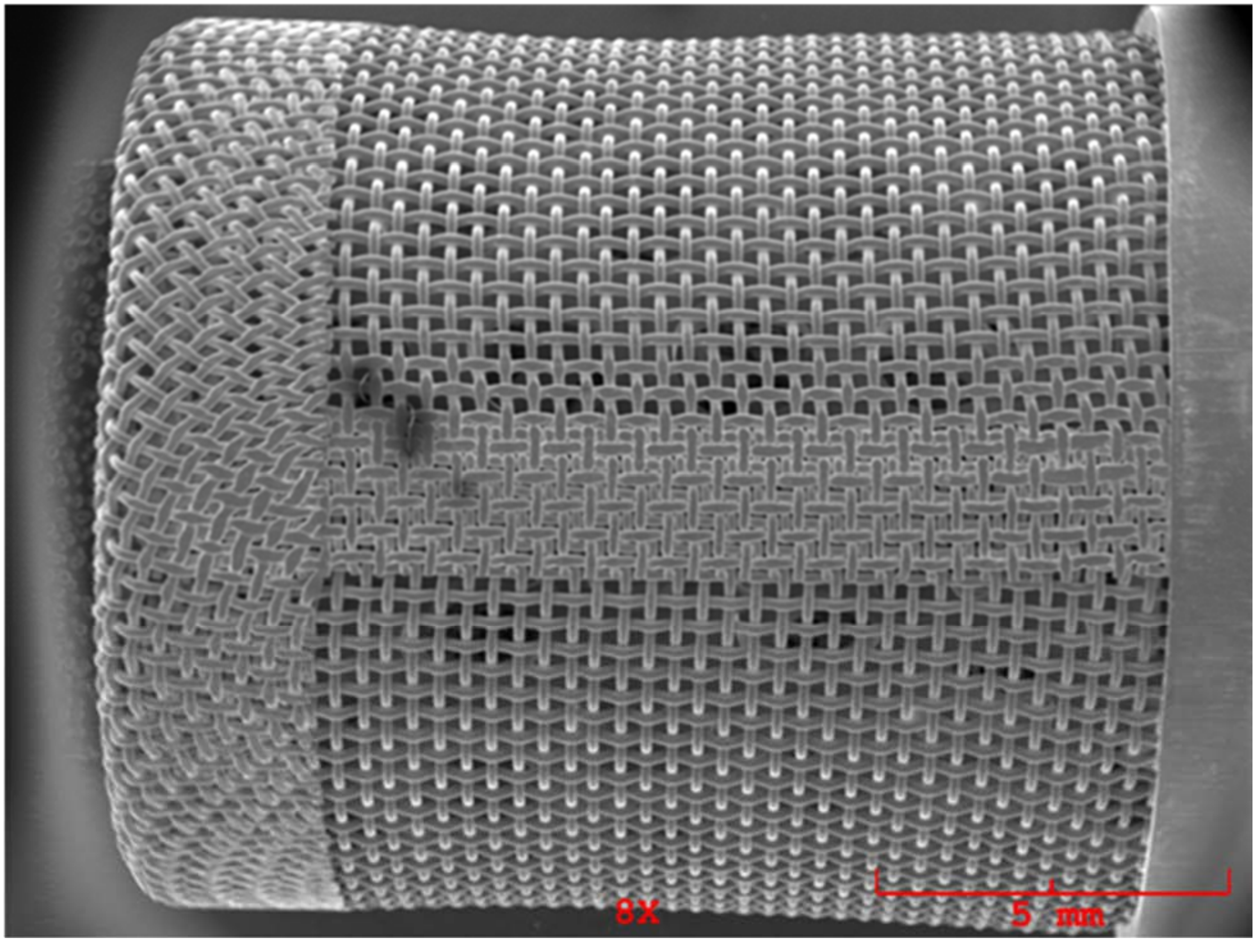
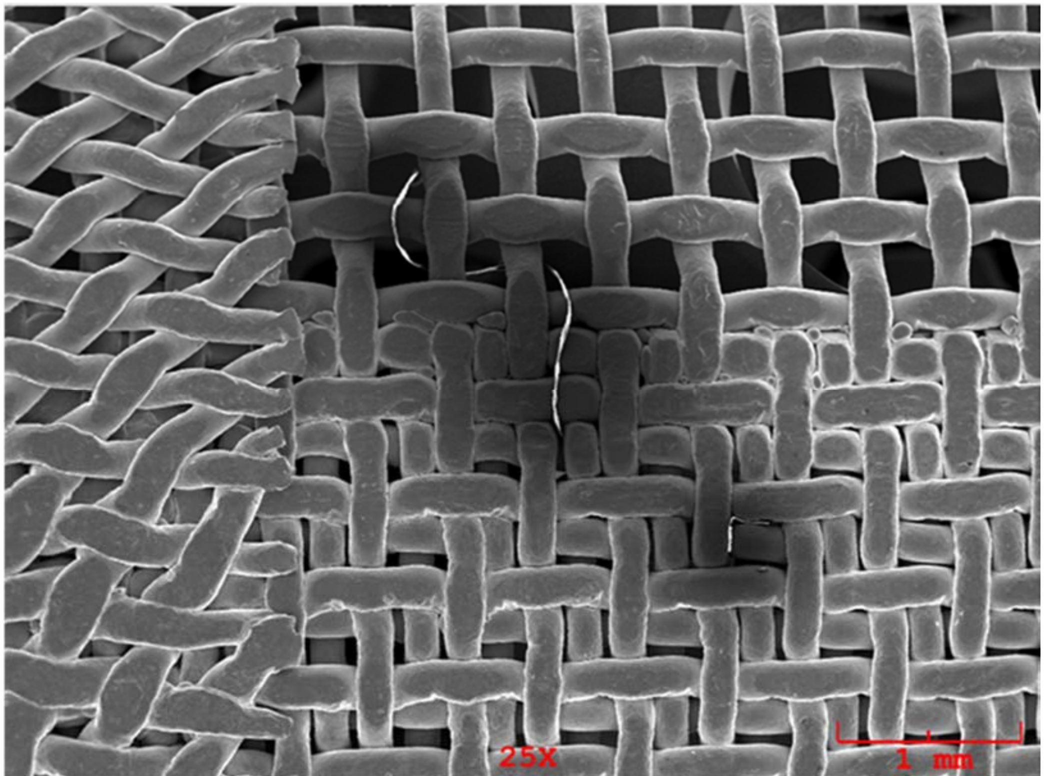


Figure K - 18 F303 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	0.37	0.216	wt.%	0.325	0.486	
Al	Ka	0.67	0.098	wt.%	0.131	0.197	
Si	Ka	3.40	0.396	wt.%	0.119	0.169	
S	Ka	10.18	0.927	wt.%	0.110	0.143	
Cr	Ka	135.72	16.735	wt.%	0.312	0.187	
Fe	Ka	347.03	71.566	wt.%	0.796	0.318	
Ni	Ka	32.48	10.063	wt.%	0.438	0.397	
			100.000	wt.%			Total

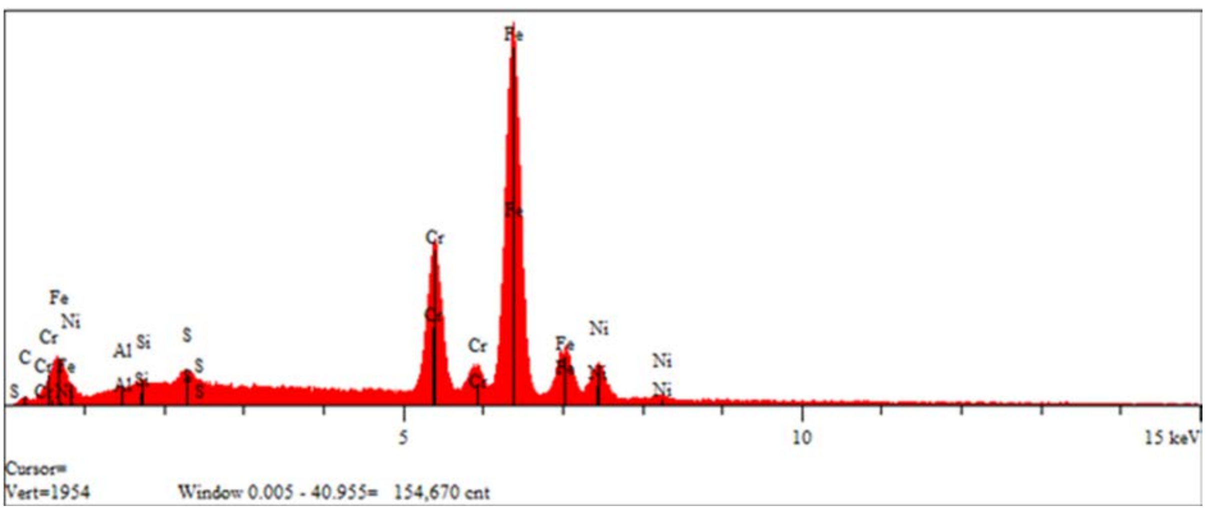


Figure K - 19 F303 Side 25X and EDX Elemental Analysis

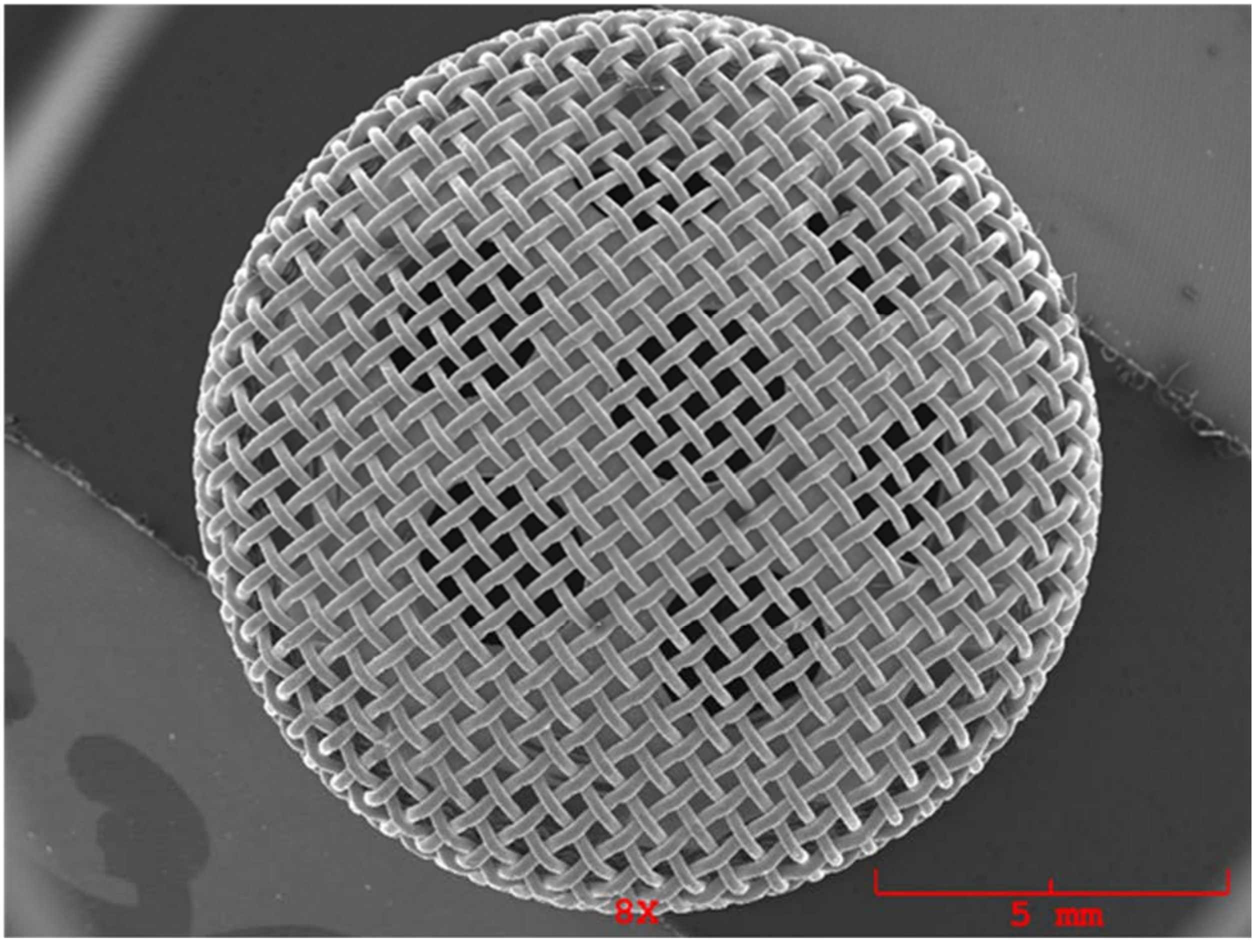
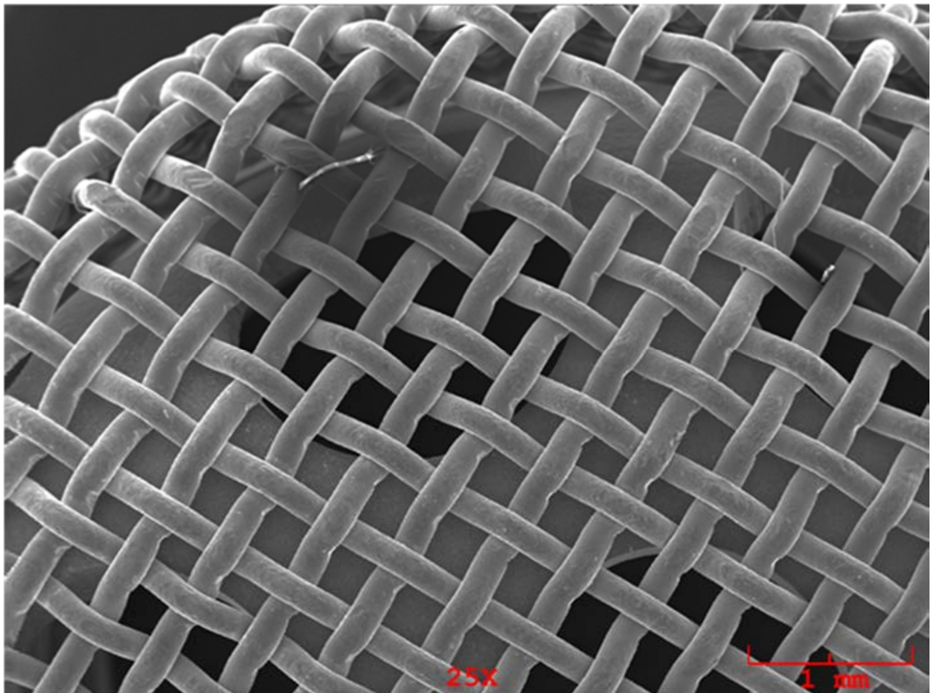


Figure K - 20 F304 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	5.73	4.057	wt.%	0.550	0.664	
O	Ka	0.00	0.000	wt.%	0.000	0.000	
Al	Ka	3.84	0.679	wt.%	0.153	0.209	
Si	Ka	2.17	0.309	wt.%	0.125	0.181	
S	Ka	8.89	0.992	wt.%	0.119	0.151	
Cr	Ka	102.42	15.670	wt.%	0.333	0.189	
Fe	Ka	267.28	68.171	wt.%	0.856	0.299	
Ni	Ka	25.06	9.580	wt.%	0.472	0.423	
Cu	Ka	1.15	0.542	wt.%	0.305	0.440	
			100.000	wt.%			Total

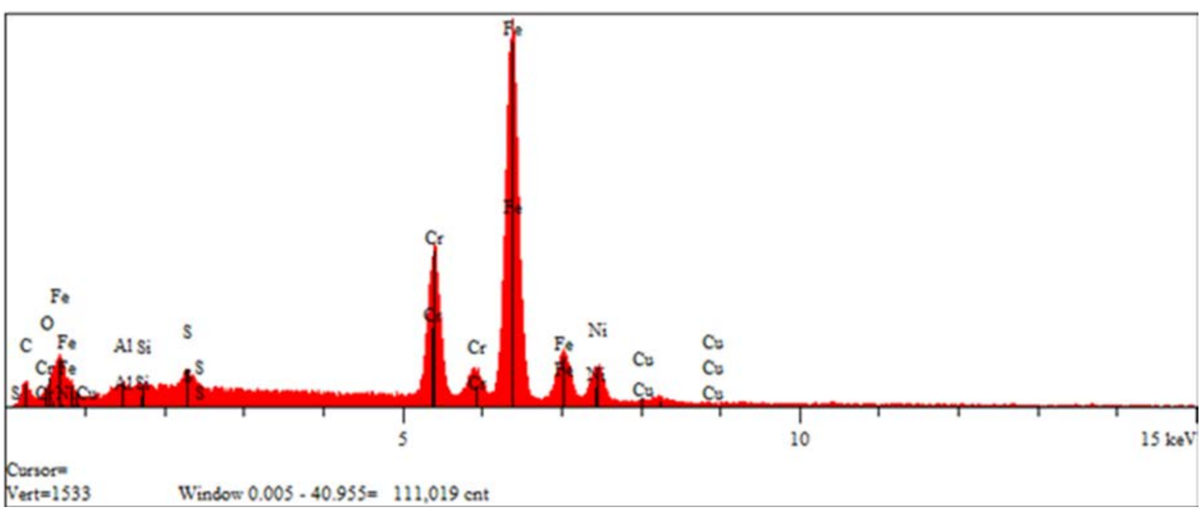


Figure K - 21 F304 Bottom, 25X and EDX Elemental Analysis

DISTRIBUTION STATEMENT A: Approved for public release. Distribution is unlimited.

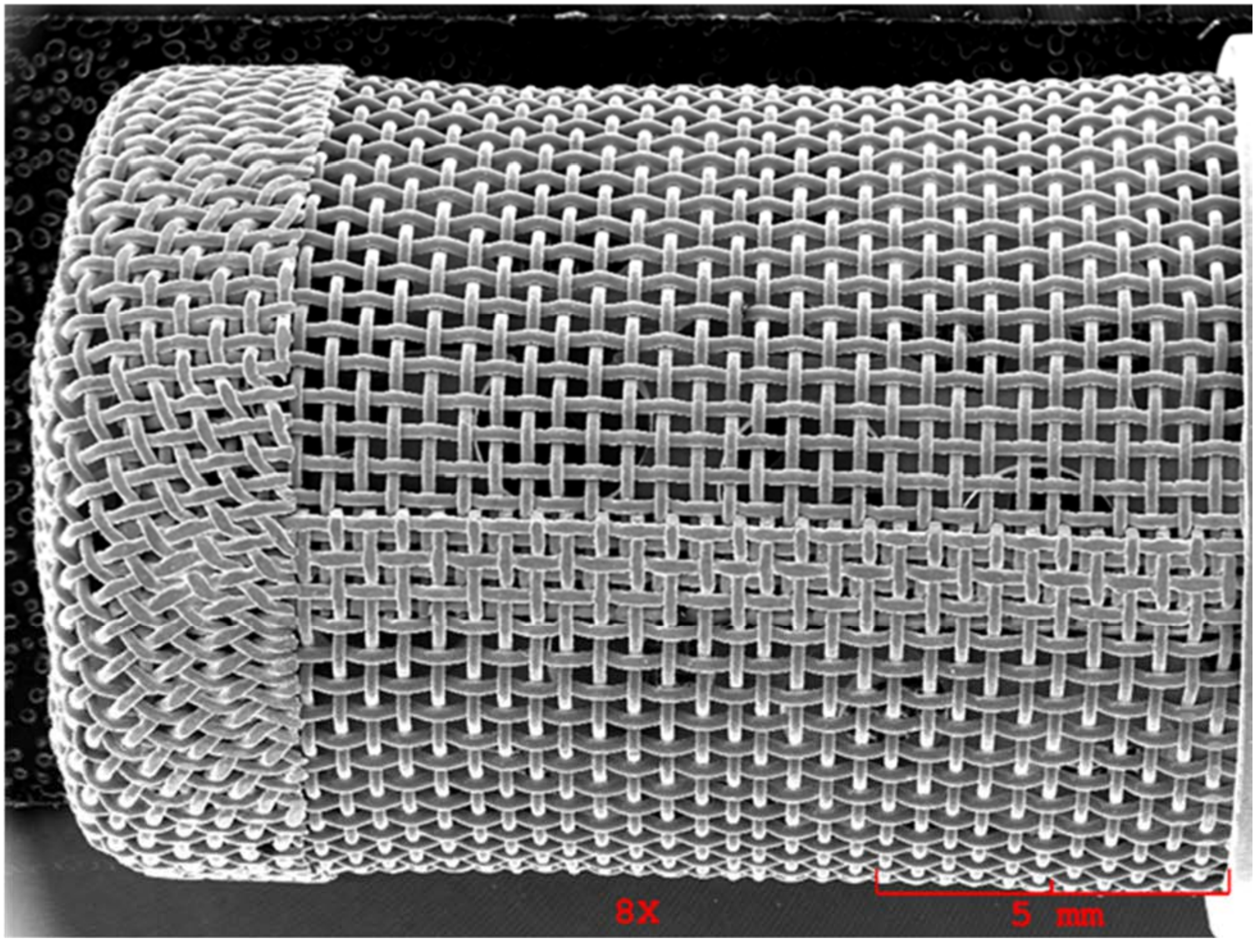
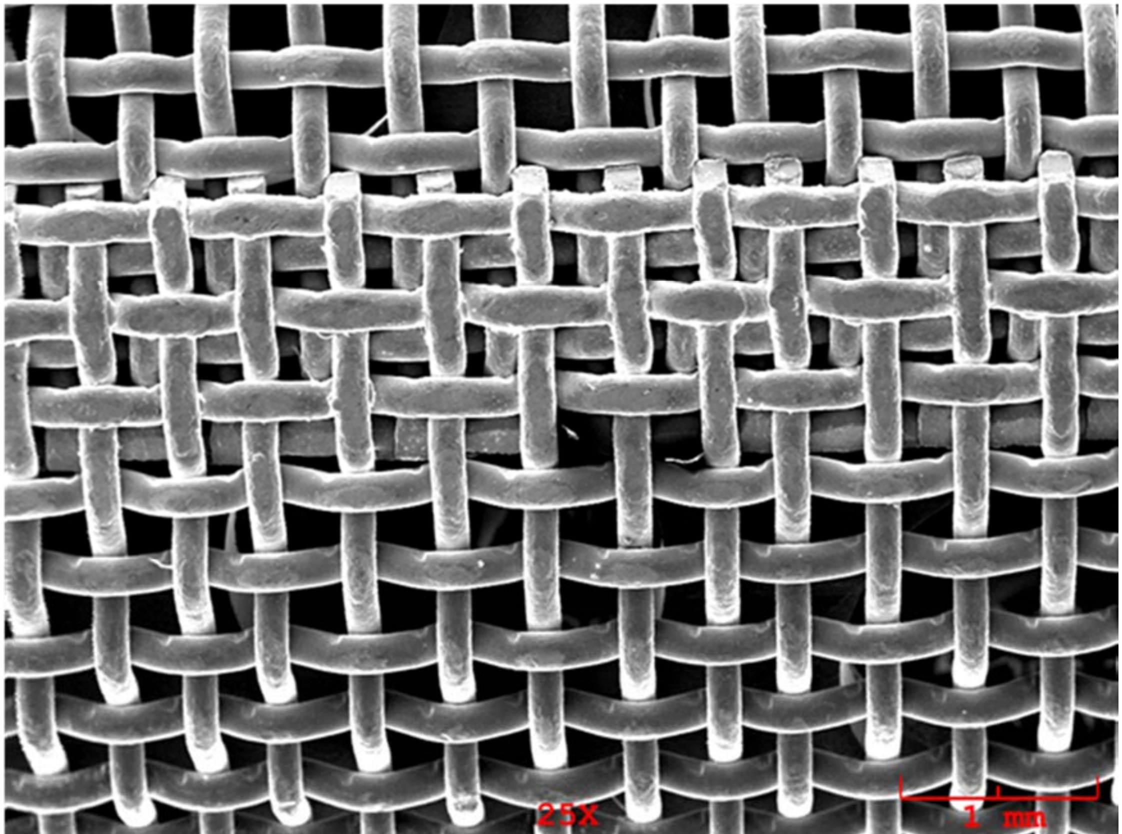


Figure K -22 F304 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	0.55	0.399	wt.%	0.414	0.612	
Si	Ka	2.27	0.330	wt.%	0.132	0.191	
S	Ka	8.46	0.960	wt.%	0.125	0.162	
Cr	Ka	105.57	16.164	wt.%	0.345	0.219	
Fe	Ka	279.70	71.851	wt.%	0.892	0.367	
Ni	Ka	26.65	10.296	wt.%	0.495	0.448	
			100.000	wt.%			Total

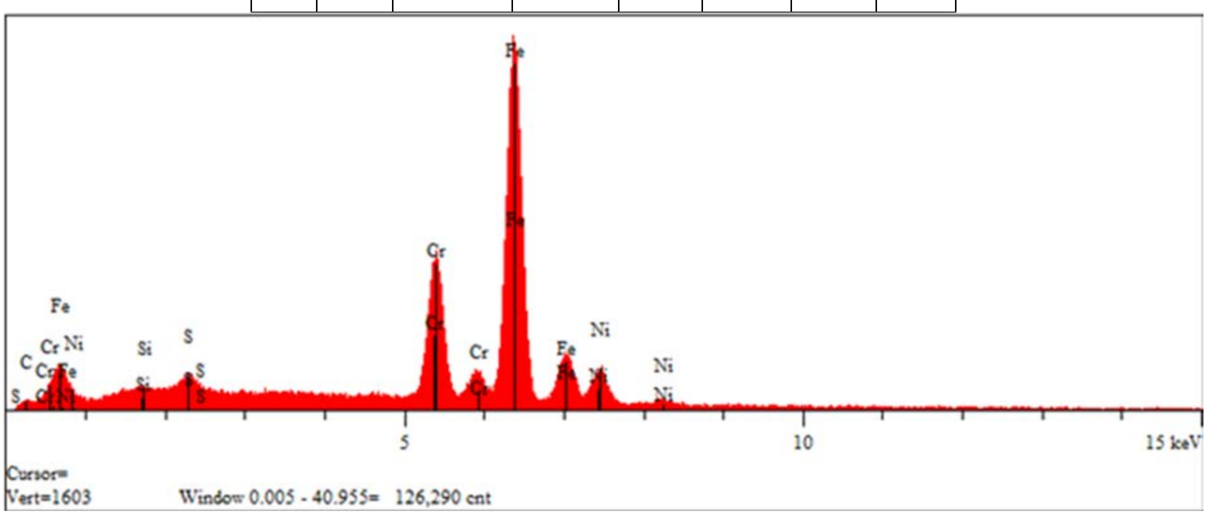


Figure K - 23 F304 Side, 25X and EDX Elemental Analysis

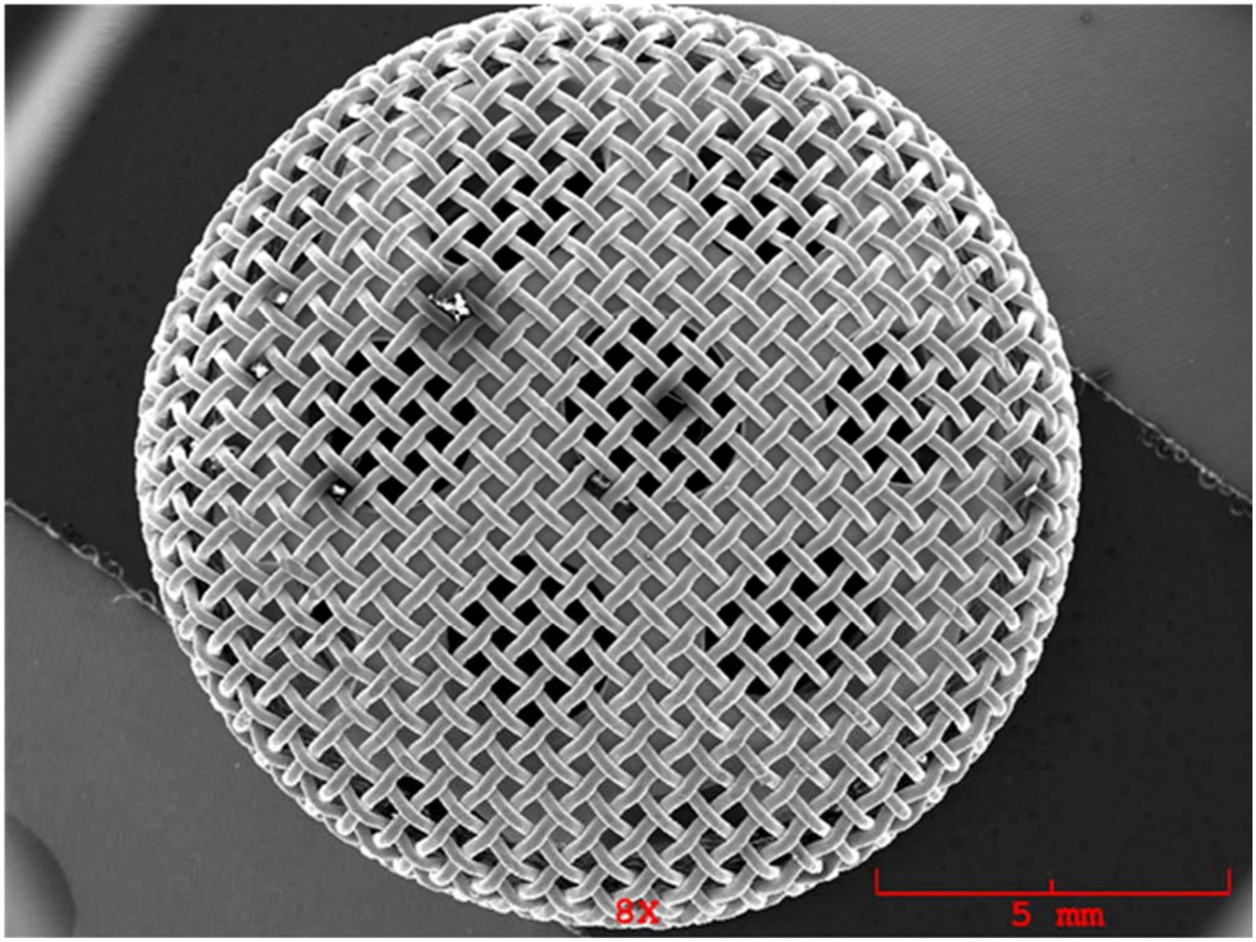
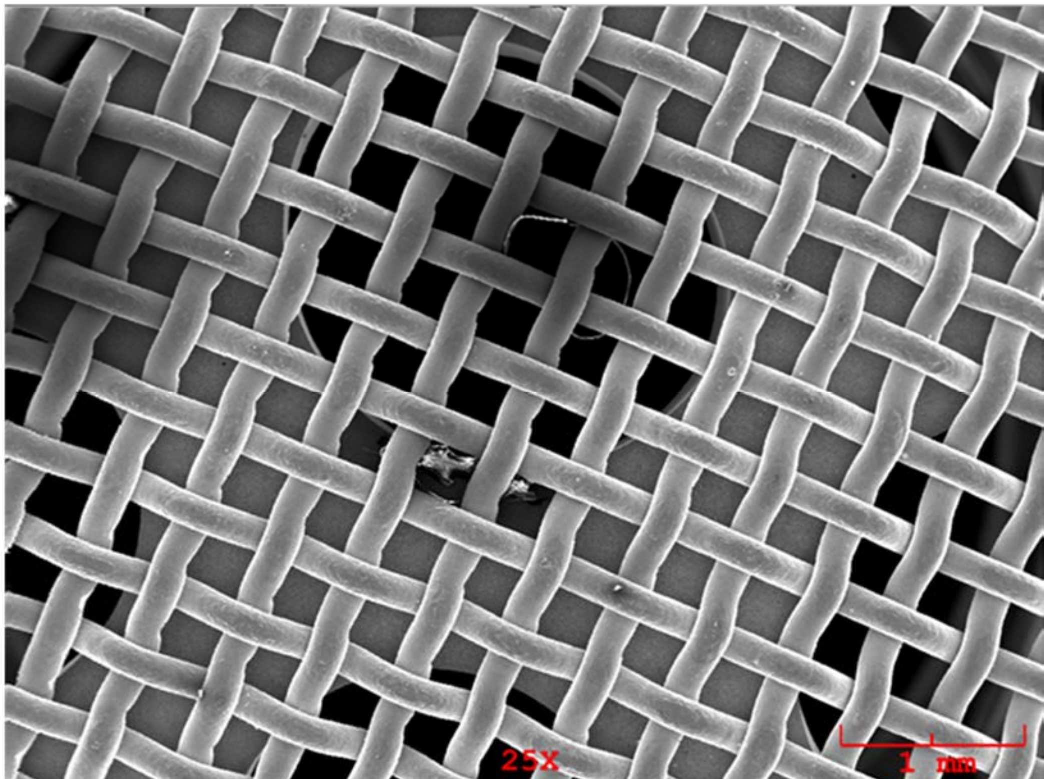


Figure K - 24 F702 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	1.54	1.192	wt.%	0.413	0.560	
O	Ka	0.00	0.000	wt.%	0.000	0.000	
Al	Ka	0.93	0.181	wt.%	0.146	0.216	
Si	Ka	3.19	0.496	wt.%	0.132	0.184	
S	Ka	6.97	0.847	wt.%	0.120	0.154	
Cr	Ka	98.07	16.123	wt.%	0.352	0.203	
Fe	Ka	258.71	71.328	wt.%	0.914	0.340	
Ni	Ka	22.88	9.477	wt.%	0.490	0.440	
Cu	Ka	0.70	0.356	wt.%	0.307	0.452	
			100.000	wt.%			Total

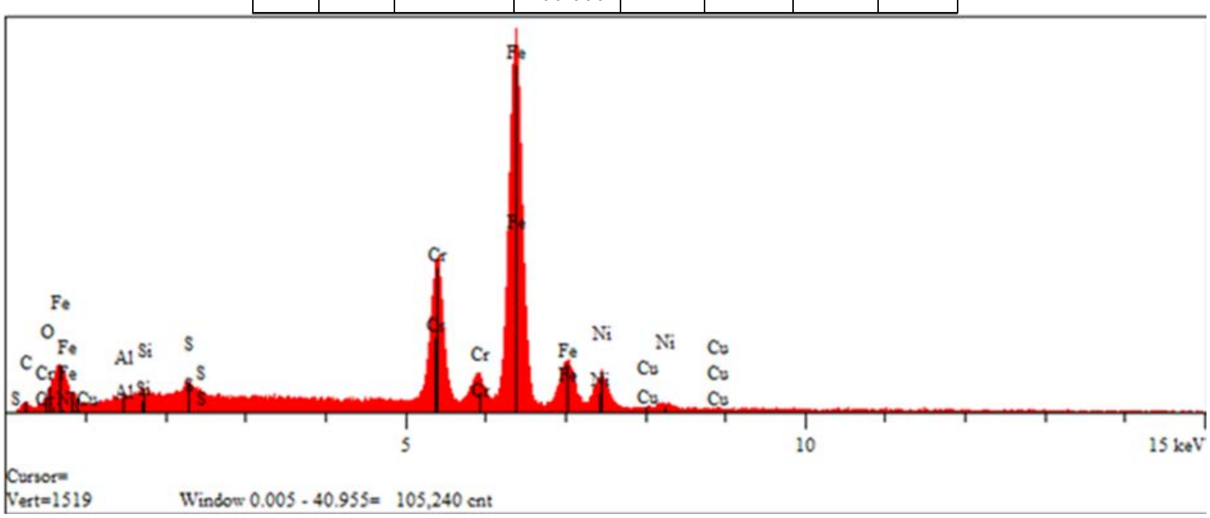


Figure K - 25 F702 Bottom, 25X and EDX Elemental Analysis

DISTRIBUTION STATEMENT A: Approved for public release. Distribution is unlimited.

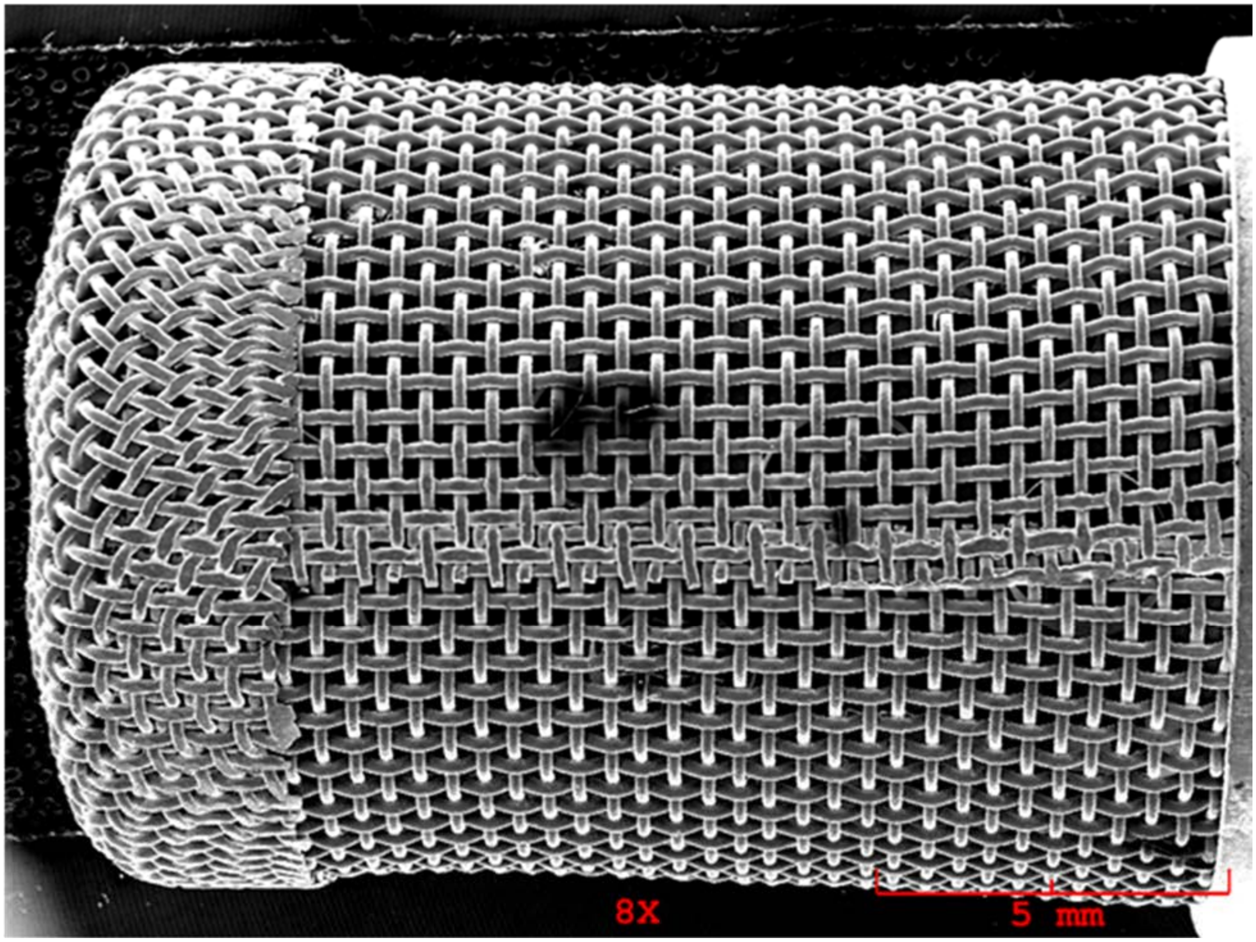
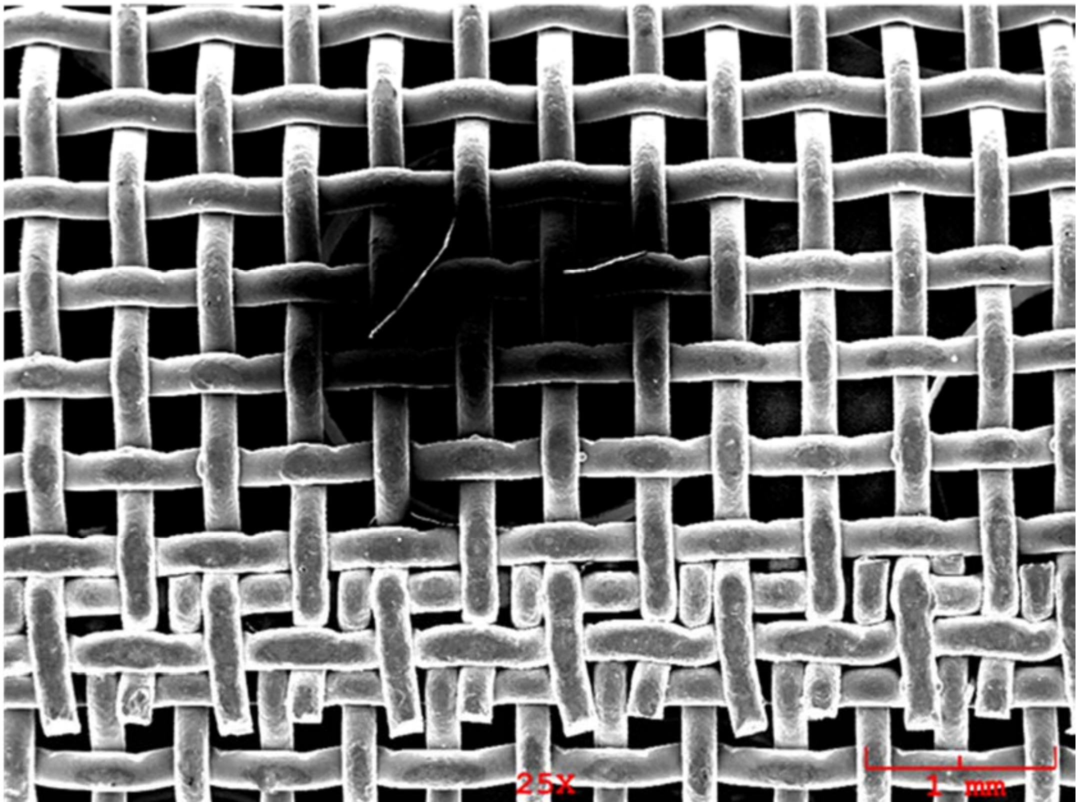


Figure K -26 F702 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	0.90	0.599	wt.%	0.360	0.516	
Si	Ka	3.72	0.495	wt.%	0.124	0.173	
S	Ka	9.60	0.999	wt.%	0.117	0.149	
Cr	Ka	112.94	15.849	wt.%	0.326	0.203	
Fe	Ka	304.19	71.634	wt.%	0.853	0.354	
Ni	Ka	29.42	10.424	wt.%	0.469	0.412	
			100.000	wt.%			Total

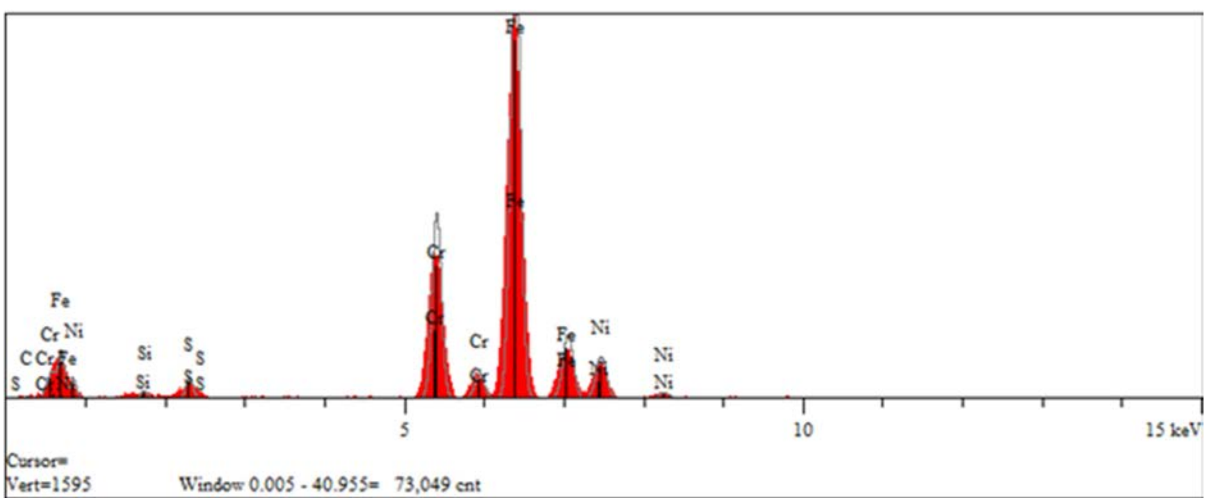


Figure K -27 F702 Side, 25X and EDX Elemental Analysis

APPENDIX L - RUN 157 DATA PACKAGE

Run Conditions: EDTST Mode, HT Conditions

Fuel ID: POSF-12831, Gulf Coast Jet A

Airframe Heat Exchanger Bulk Fuel Output: 285 °F

HP Pump HX Out/FCOC Bulk Fuel In: 350 °F

Fuel-Cooled Oil Cooler Bulk Fuel Output: 375 °F

Burner Feed Arm Max Wetted Wall Temperature: 510 °F

Run Duration: 72 Hours

DATA SUMMARY

Run 157; Run Type: EDTST; Op Mode: HT; MSNs: N/A; EDTST Run Hours: 72 Fuel ID#: POSF12831; Run Tank: S-15; Run Type: EDTST; Op Mode: HT Fuel Type: Jet-A; Additive(s): None AFHX Out: 285 °F; FCOC In: 325 °F; FCOC Out: 375 °F; BFA MWWT: 510 °F;

Component/Device	Serial No.	Pre-Test %	Post-Test %	Spread (Pre/Post Delta), %	Shift, PPH	Skew, PSID	Flow Range Shift, PPH	Flow Midpoint Shift, PPH	Overall Rating	Hysteresis Area Change (PPH-DP)
FDV	1153	3.3	31.4	28.1	-5.6	3.1	-8.2	-4.1	Non-Funct	232
Servo2	029	3.3	17.0	13.7	-3.1	-0.5	-0.6	-0.3	Non-Funct	871

Effective Carbon - µgrams

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	258.4	229.3	82.9	71.3	1.5					
BFA	334.6	513.3	674.6	727.7	820.4	906.6	868.9	837.4	706.1	0.0
Total FCOC Carbon, µgrams	176.4	µgrams	0.2	mgrams						
Total BFA Carbon, µgrams	3708.8	µgrams	3.7	mgrams						

SCREENS	Total Carbon, µg	Background Carbon, µg	Effective Carbon, µg	MWWT Start	MWWT End	Delta BFA MWWT	TE	BFA AWWT Start	BFA AWWT End	Delta BFA AWWT
TMS	138.5	0.3	138.1	511.51	498.44	-9.09	MAX	496.23	490.54	-5.69
F303	265.3	25.4	239.9	502.42	489.36	-13.06	TE325	**SV Inlet (TE702)**	**FDV Inlet (TE313)**	**BFA Inlet (TE316)**
F304	159.1	12.9	146.2	506.34	492.81	-13.54	TE324			
F305	0.0	0.0	0.0	511.51	498.44	-13.06	TE323	367	351	345
F702	2998.9	12.9	2986.0	505.88	496.79	-9.09	TE322			

Effective Carbon Deposition - µgrams/cm^2

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	70.8	62.9	22.7	19.6	0.4					
BFA	194.2	297.9	391.5	422.4	476.2	526.2	504.4	486.0	409.9	0.0

TMS Mass Change - grams

Component/Device	Tare, g	Mass, g	Mass Gain, g
TMS	0.08636	0.08696	0.00060
F303	7.19704	7.19756	0.00052
F304	3.06214	3.06258	0.00044
F305	0.00000	0.00000	0.00000
F702	3.05502	3.06144	0.00642

Hysteresis Ratings:

- NONE: indicating that the pre-test and post-test hysteresis curves, for all intents and purposes, are nearly indistinguishable from one another. Minor differences may be seen between the pre-test and post-test curves but these are very small.
- Minor: There are small differences between per- and post-test curves. The spread for these curves is typically within 5% of one another. There may be some small changes in shift and skew for the valve. This degree of hysteresis would not be expected to alter the functional nature of the valve.
- Moderate: There are definite differences between pre-and post-test curves. There may be definite differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically between 5% and 15%. This degree of hysteresis might be expected to alter the functional nature of the valve.
- Severe: There are pronounce differences between pre-and post-test curves. There may be pronounced differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically in excess 15%. This degree of hysteresis would be considered out-of-spec for the valve.
- Non-Functional: There are major differences between pre-and post-test curves. There may be major differences in shift and skew as well. The hysteresis curve will exhibit flat segments (either vertically or horizontally). Shift and skew have majorly changed the performance envelope of the valve. This degree of hysteresis would cause the valve to be non-functional or unresponsive over small or large portions of the performance range of the valve.

Figure L- 1 Run 157 Data Summary

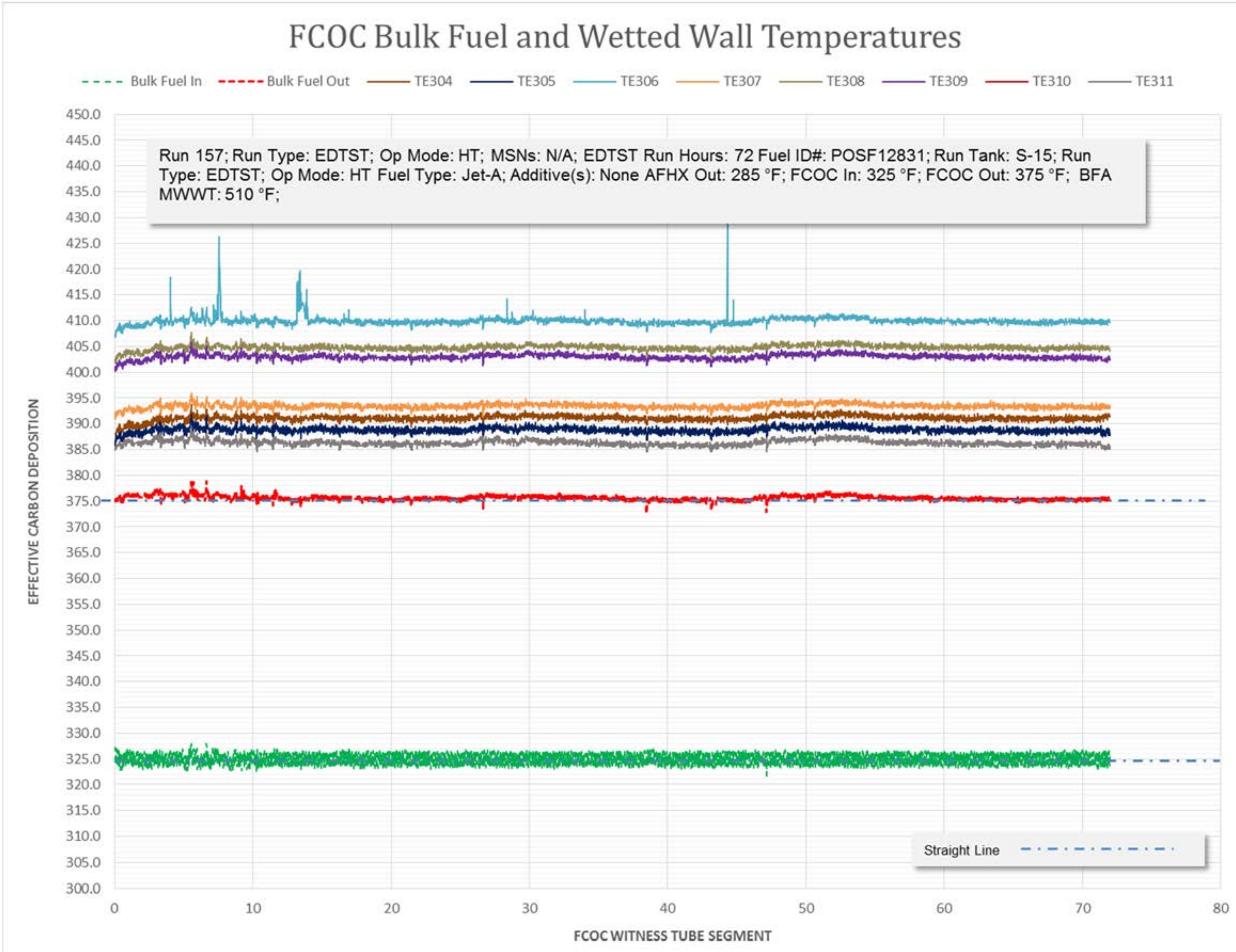


Figure L- 2 FCOC Bulk Fuel and Wetted Wall Temperatures

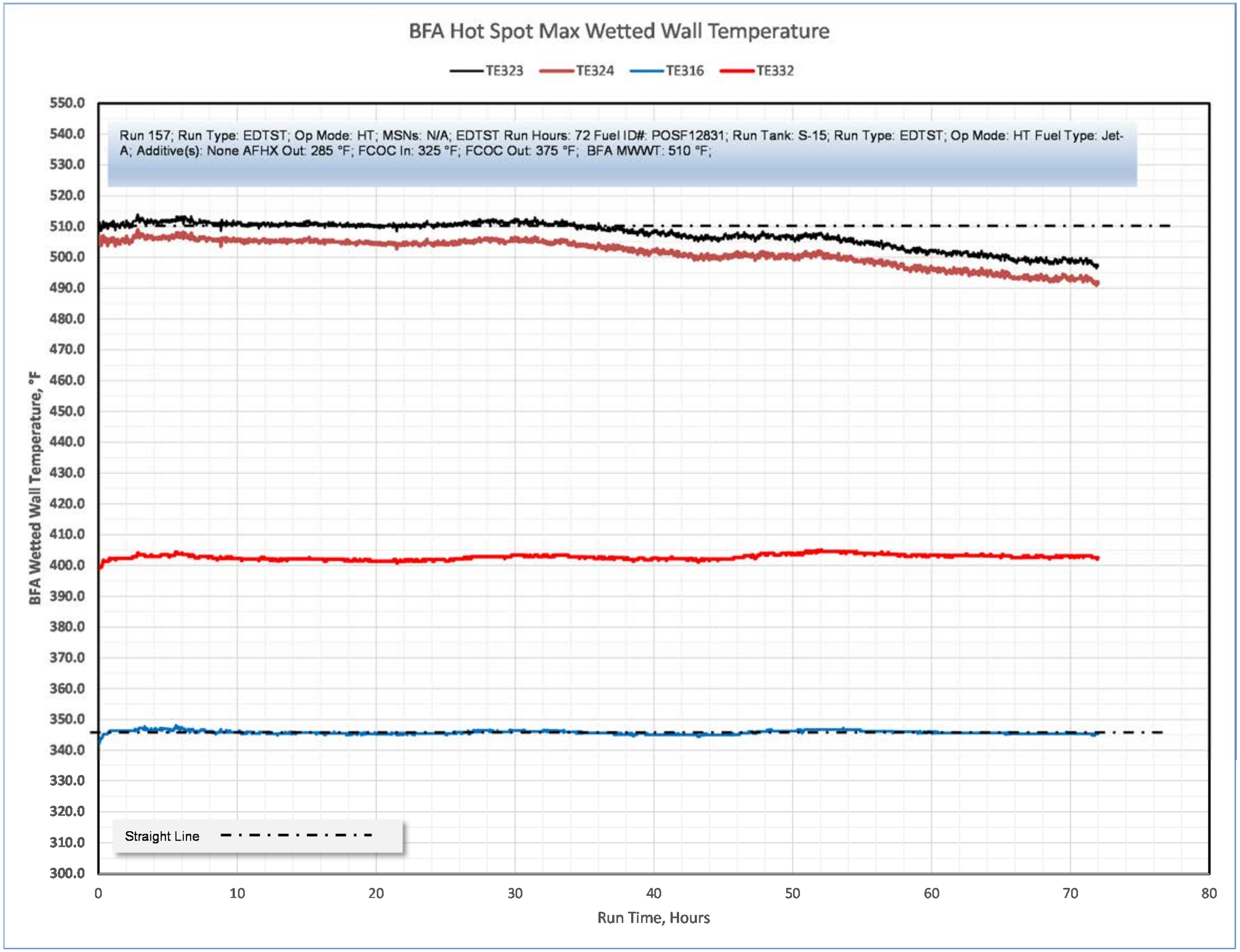


Figure L- 3 BFA Hot Spot Max Wetted Wall And Bulk Fuel Temperatures

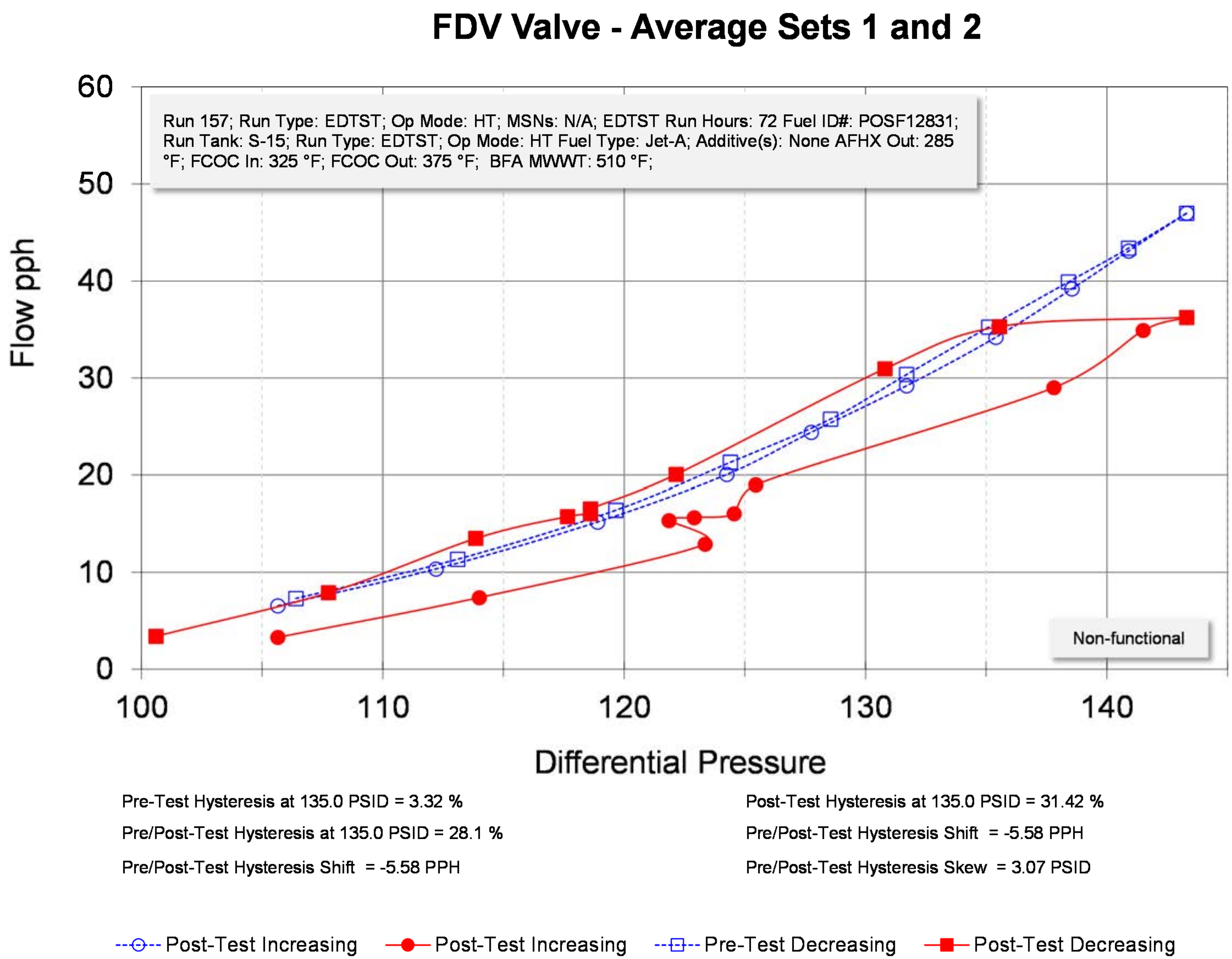


Figure L- 4 FDV Hysteresis

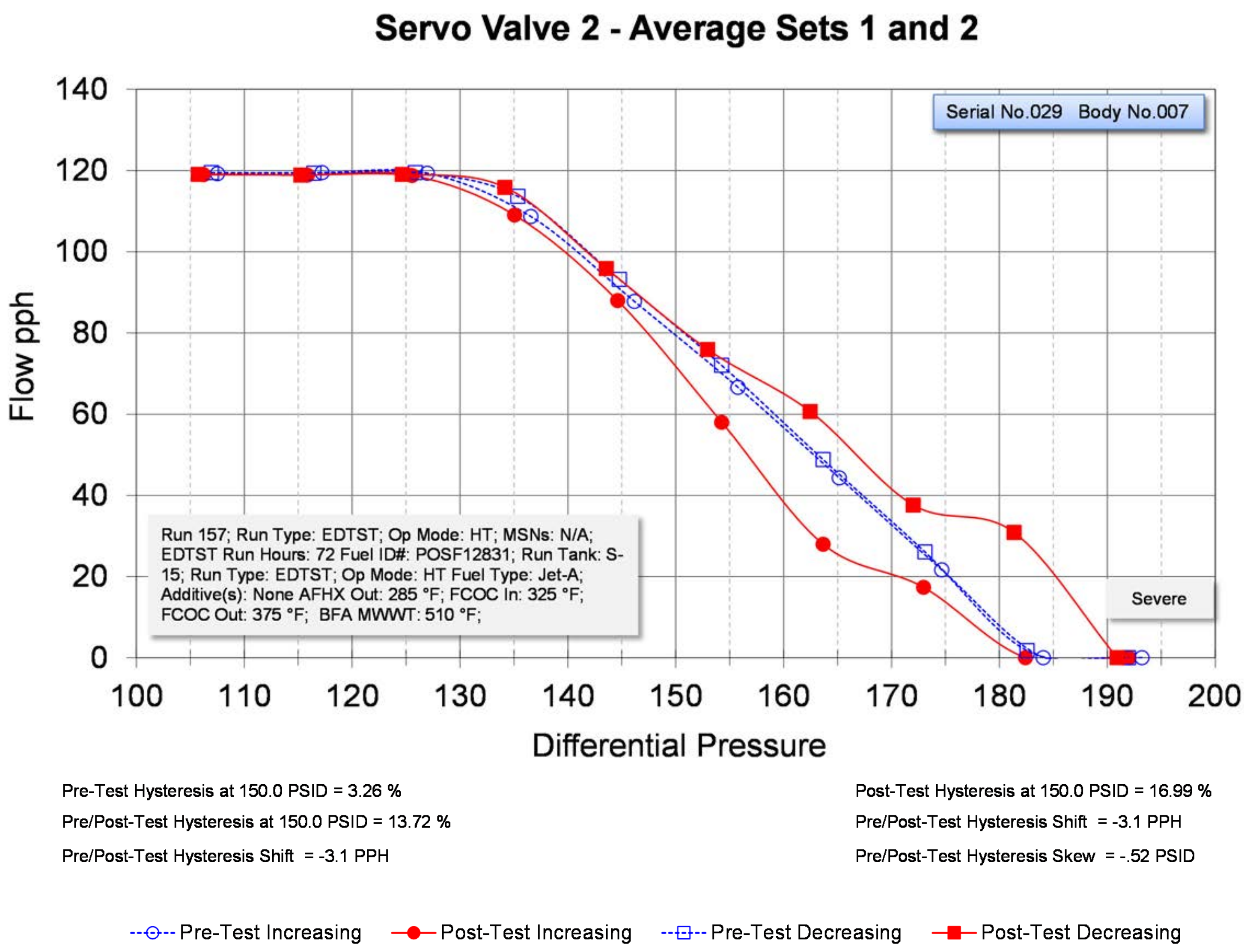


Figure L- 5 Servo Valve Hysteresis

FDV Components Comparison to Clean Run 157

Figure L- 6 FDV Components - Comparison to Clean

Servo Valve and Nozzle Screen Simulator Components – Comparison To Clean - Run 157

Run 157

Clean

Run 157 POSF-12831 HT

Figure L- 7 Servo Valve and Nozzle Screen Components - Comparison to Clean

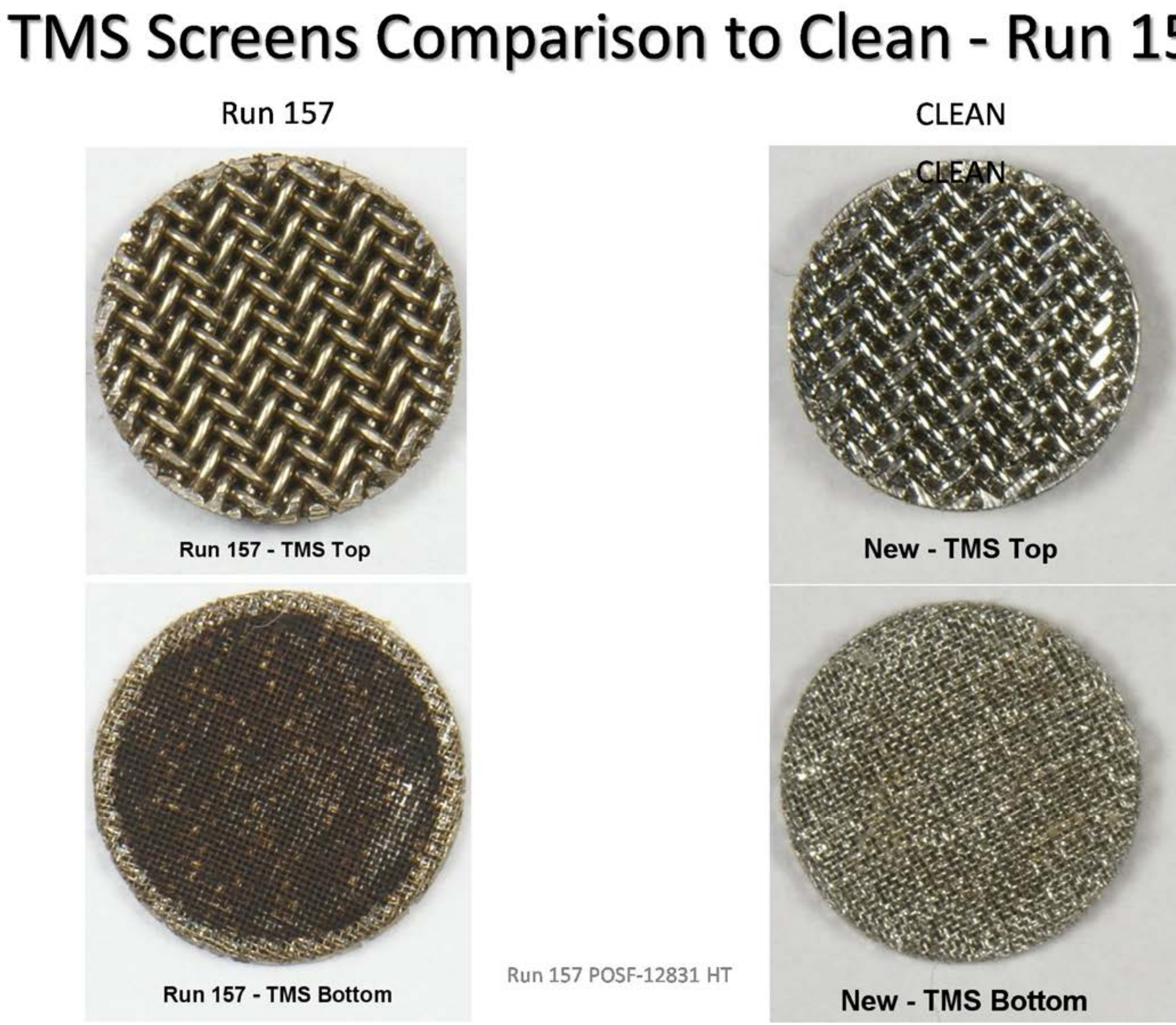


Figure L- 8 TMS Screen Top and Bottom - Comparison to Clean

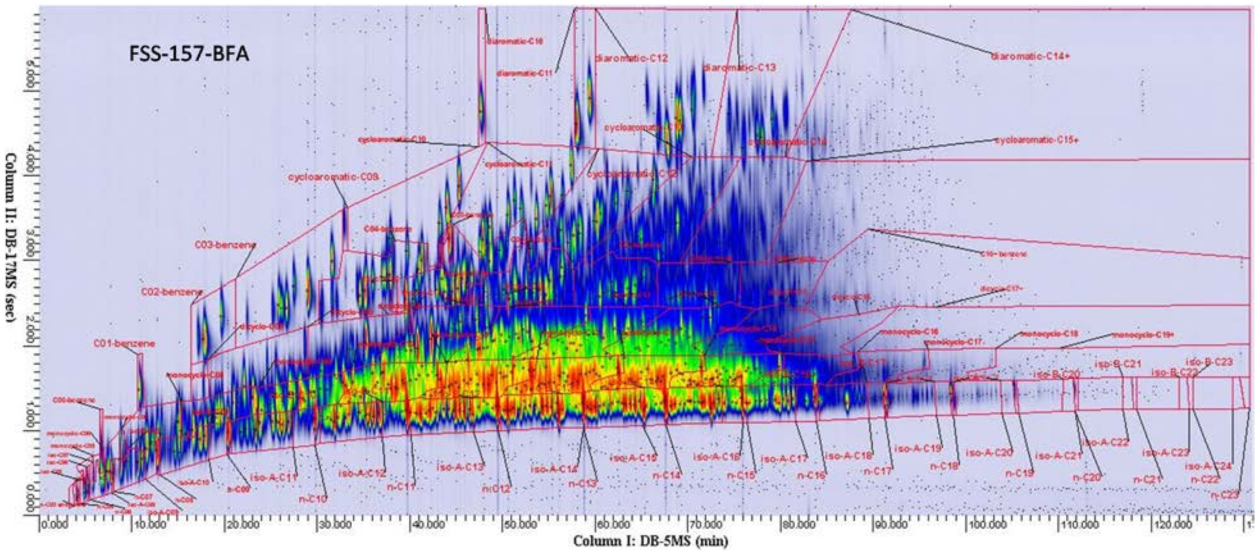


Figure L- 9 GCxGC Summary POSF-12831 BFA Outlet

Table L - 1 GCxGC Tabulated Data POSF-12831 Jet A Neat and Run 151 BFA Outlet

GCxGC Summary				
Hydrogen content (weight %)	13.9		13.9	
Average Molecular Wt (g/mole)	168		170	
	POSF-12831-Jet A Neat		FSS157-BFA	
	Weight %	Volume %	Weight %	Volume %
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	<0.01	<0.01
toluene (C07)	0.10	0.10	0.08	0.07
C2-benzene (C08)	0.42	0.39	0.34	0.32
C3-benzene (C09)	0.88	0.82	0.85	0.79
C4-benzene (C10)	1.47	1.37	1.44	1.34
C5-benzene (C11)	1.78	1.66	1.66	1.54
C6-benzene (C12)	1.69	1.58	1.69	1.57
C7-benzene (C13)	1.21	1.13	1.26	1.18
C8-benzene (C14)	0.99	0.92	1.04	0.97
C9-benzene (C15)	0.55	0.51	0.61	0.57
C10+-benzene (C16+)	0.24	0.23	0.29	0.27
Total Alkylbenzenes	**9.33**	8.69	**9.25**	8.62
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.10	0.08
diaromatic-C11	0.51	0.40	0.48	0.38
diaromatic-C12	0.96	0.77	0.96	0.77
diaromatic-C13	0.58	0.47	0.62	0.51
diaromatic-C14+	0.18	0.15	0.21	0.17
Total Alkylnaphthalenes	**2.33**	1.87	**2.37**	1.91
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.03	0.02	0.03	0.02
cycloaromatic-C10	0.53	0.44	0.45	0.37
cycloaromatic-C11	1.54	1.32	1.42	1.22
cycloaromatic-C12	1.67	1.45	1.58	1.38
cycloaromatic-C13	1.54	1.35	1.60	1.40
cycloaromatic-C14	0.94	0.83	1.02	0.90
cycloaromatics-C15+	0.30	0.26	0.37	0.32
Total Cycloaromatics	**6.56**	5.67	**6.47**	5.60
Total Aromatics	**18.22**	**16.24**	**18.09**	**16.13**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.24	0.29	0.19	0.22
C08-isoparaffins	0.43	0.49	0.33	0.38
C09-isoparaffins	0.58	0.65	0.55	0.61
C10-isoparaffins	1.46	1.61	1.64	1.82
C11-isoparaffins	2.76	2.99	2.88	3.11
C12-isoparaffins	4.56	4.94	4.26	4.61
C13-isoparaffins	4.75	5.04	4.71	4.99
C14-isoparaffins	4.49	4.72	4.62	4.86
C15-isoparaffins	3.64	3.81	3.87	4.04
C16-isoparaffins	1.50	1.55	1.70	1.77
C17-isoparaffins	0.46	0.47	0.52	0.53
C18-isoparaffins	0.15	0.16	0.18	0.18
C19-isoparaffins	0.08	0.08	0.09	0.09
C20-isoparaffins	0.05	0.05	0.05	0.05
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01
Total iso-Paraffins	**25.16**	26.85	**25.60**	27.29

n-Paraffins				
n-C07 & lower	0.19	0.22	0.14	0.17
n-C08	0.38	0.43	0.31	0.35
n-C09	0.56	0.62	0.51	0.57
n-C10	1.00	1.10	1.07	1.17
n-C11	2.89	3.13	2.74	2.97
n-C12	3.11	3.32	3.03	3.23
n-C13	2.77	2.94	2.86	3.03
n-C14	2.38	2.50	2.55	2.68
n-C15	1.40	1.46	1.54	1.61
n-C16	0.34	0.36	0.42	0.44
n-C17	0.12	0.13	0.15	0.15
n-C18	0.04	0.04	0.05	0.05
n-C19	0.02	0.02	0.02	0.02
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**15.22**	16.30	**15.39**	16.45
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.49	0.51	0.38	0.40
C08-monocyclocycloparaffins	0.71	0.72	0.55	0.56
C09-monocyclocycloparaffins	1.49	1.51	1.17	1.18
C10-monocyclocycloparaffins	2.36	2.32	2.11	2.07
C11-monocyclocycloparaffins	5.59	5.63	4.93	4.96
C12-monocyclocycloparaffins	5.49	5.49	5.88	5.89
C13-monocyclocycloparaffins	5.81	5.75	6.17	6.11
C14-monocyclocycloparaffins	4.05	4.02	4.33	4.30
C15-monocyclocycloparaffins	2.58	2.55	2.85	2.82
C16-monocyclocycloparaffins	0.93	0.92	0.85	0.84
C17-monocyclocycloparaffins	0.23	0.22	0.31	0.31
C18-monocyclocycloparaffins	0.06	0.06	0.06	0.06
C19+-monocyclocycloparaffins	0.04	0.03	0.04	0.04
Total Monocycloparaffins	**29.82**	29.73	**29.66**	29.55
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.27	0.25	0.27	0.25
C10-dicycloparaffins	0.71	0.64	0.72	0.64
C11-dicycloparaffins	2.43	2.28	2.06	1.94
C12-dicycloparaffins	2.60	2.46	2.63	2.48
C13-dicycloparaffins	2.89	2.73	2.73	2.58
C14-dicycloparaffins	1.89	1.78	1.86	1.76
C15-dicycloparaffins	0.63	0.59	0.75	0.71
C16-dicycloparaffins	0.04	0.03	0.13	0.13
C17+-dicycloparaffins	0.03	0.03	0.03	0.03
Total Dicycloparaffins	**11.50**	10.81	**11.19**	10.52
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.07	0.06	0.07	0.06
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.08**	0.06	**0.07**	0.06
Total Cycloparaffins	**41.40**	40.61	**40.92**	40.13
Average Molecular Formula - C	12.1		12.2	
Average Molecular Formula - H	23.2		23.5	

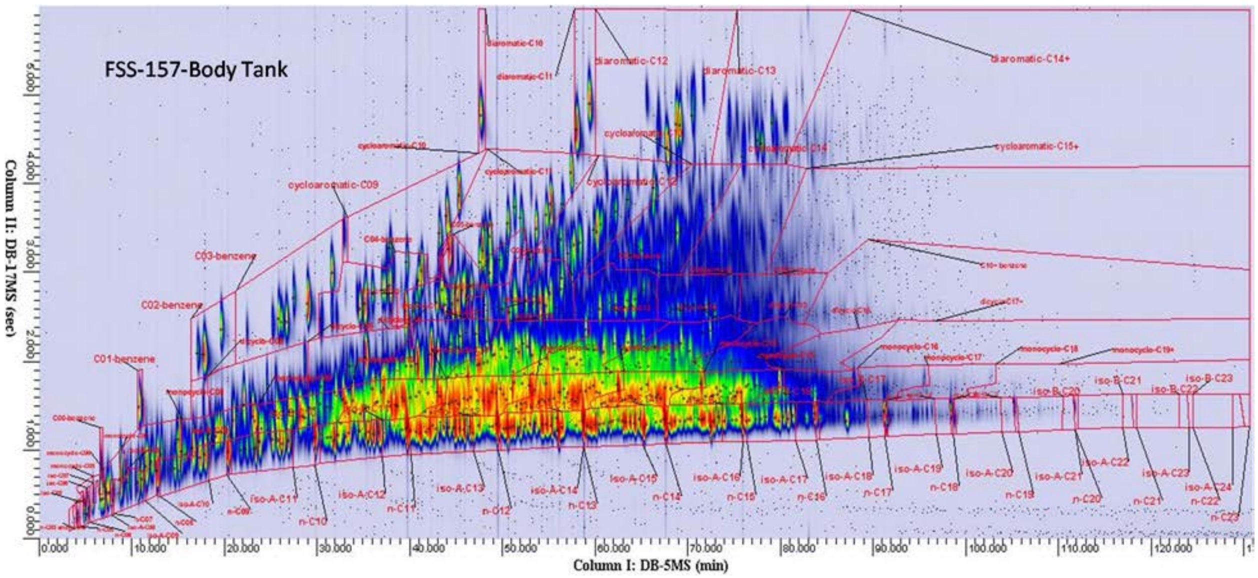


Figure L- 10 GCxGC Summary Fuel From Body Tank

Table L - 2 GCxGC Tabulated Data - Fuel From Body Tank at the End Of Run

	POSF-12831-Jet A Neat		FSS157-Body Tar	
Hydrogen content (weight %)	13.9		13.9	
Average Molecular Wt (g/mole)	168		168	
	Weight %	Volume %	Weight %	Volume %
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	<0.01	<0.01
toluene (C07)	0.10	0.10	0.10	0.09
C2-benzene (C08)	0.42	0.39	0.41	0.38
C3-benzene (C09)	0.88	0.82	0.86	0.80
C4-benzene (C10)	1.47	1.37	1.47	1.37
C5-benzene (C11)	1.78	1.66	1.75	1.63
C6-benzene (C12)	1.69	1.58	1.68	1.56
C7-benzene (C13)	1.21	1.13	1.27	1.18
C8-benzene (C14)	0.99	0.92	0.98	0.92
C9-benzene (C15)	0.55	0.51	0.56	0.53
C10+-benzene (C16+)	0.24	0.23	0.22	0.21
Total Alkylbenzenes	**9.33**	8.69	**9.31**	8.67
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.11	0.08
diaromatic-C11	0.51	0.40	0.50	0.39
diaromatic-C12	0.96	0.77	0.94	0.75
diaromatic-C13	0.58	0.47	0.57	0.47
diaromatic-C14+	0.18	0.15	0.15	0.12
Total Alkylnaphthalenes	**2.33**	1.87	**2.27**	1.82
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.03	0.02	0.03	0.02
cycloaromatic-C10	0.53	0.44	0.52	0.43
cycloaromatic-C11	1.54	1.32	1.54	1.32
cycloaromatic-C12	1.67	1.45	1.63	1.41
cycloaromatic-C13	1.54	1.35	1.52	1.33
cycloaromatic-C14	0.94	0.83	0.95	0.83
cycloaromatics-C15+	0.30	0.26	0.30	0.27
Total Cycloaromatics	**6.56**	5.67	**6.47**	5.60
Total Aromatics	**18.22**	**16.24**	**18.05**	**16.09**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.24	0.29	0.23	0.28
C08-isoparaffins	0.43	0.49	0.41	0.47
C09-isoparaffins	0.58	0.65	0.63	0.71
C10-isoparaffins	1.46	1.61	1.46	1.61
C11-isoparaffins	2.76	2.99	2.82	3.05
C12-isoparaffins	4.56	4.94	4.52	4.90
C13-isoparaffins	4.75	5.04	4.65	4.92
C14-isoparaffins	4.49	4.72	4.62	4.86
C15-isoparaffins	3.64	3.81	3.64	3.80
C16-isoparaffins	1.50	1.55	1.52	1.58
C17-isoparaffins	0.46	0.47	0.46	0.47
C18-isoparaffins	0.15	0.16	0.15	0.16
C19-isoparaffins	0.08	0.08	0.07	0.07
C20-isoparaffins	0.05	0.05	0.05	0.05
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01
Total iso-Paraffins	**25.16**	26.85	**25.25**	26.93

n-Paraffins				
n-C07 & lower	0.19	0.22	0.18	0.22
n-C08	0.38	0.43	0.37	0.42
n-C09	0.56	0.62	0.55	0.61
n-C10	1.00	1.10	1.01	1.11
n-C11	2.89	3.13	2.89	3.13
n-C12	3.11	3.32	3.16	3.38
n-C13	2.77	2.94	2.80	2.97
n-C14	2.38	2.50	2.52	2.65
n-C15	1.40	1.46	1.43	1.49
n-C16	0.34	0.36	0.35	0.37
n-C17	0.12	0.13	0.13	0.13
n-C18	0.04	0.04	0.04	0.04
n-C19	0.02	0.02	0.02	0.02
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**15.22**	16.30	**15.47**	16.56
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.49	0.51	0.49	0.51
C08-monocyclocycloparaffins	0.71	0.72	0.67	0.69
C09-monocyclocycloparaffins	1.49	1.51	1.40	1.42
C10-monocyclocycloparaffins	2.36	2.32	2.26	2.22
C11-monocyclocycloparaffins	5.59	5.63	5.39	5.42
C12-monocyclocycloparaffins	5.49	5.49	6.12	6.13
C13-monocyclocycloparaffins	5.81	5.75	5.61	5.56
C14-monocyclocycloparaffins	4.05	4.02	4.01	3.98
C15-monocyclocycloparaffins	2.58	2.55	2.54	2.51
C16-monocyclocycloparaffins	0.93	0.92	0.80	0.78
C17-monocyclocycloparaffins	0.23	0.22	0.25	0.24
C18-monocyclocycloparaffins	0.06	0.06	0.06	0.06
C19+-monocyclocycloparaffins	0.04	0.03	0.03	0.03
Total Monocycloparaffins	**29.82**	29.73	**29.63**	29.53
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.27	0.25	0.29	0.26
C10-dicycloparaffins	0.71	0.64	0.78	0.70
C11-dicycloparaffins	2.43	2.28	2.23	2.10
C12-dicycloparaffins	2.60	2.46	2.73	2.58
C13-dicycloparaffins	2.89	2.73	2.62	2.48
C14-dicycloparaffins	1.89	1.78	1.99	1.88
C15-dicycloparaffins	0.63	0.59	0.69	0.65
C16-dicycloparaffins	0.04	0.03	0.15	0.14
C17+-dicycloparaffins	0.03	0.03	0.03	0.03
Total Dicycloparaffins	**11.50**	10.81	**11.52**	10.83
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.07	0.06	0.07	0.06
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.08**	0.06	**0.07**	0.06
Total Cycloparaffins	**41.40**	40.61	**41.23**	40.42
Average Molecular Formula - C	12.1		12.1	
Average Molecular Formula - H	23.2		23.2	

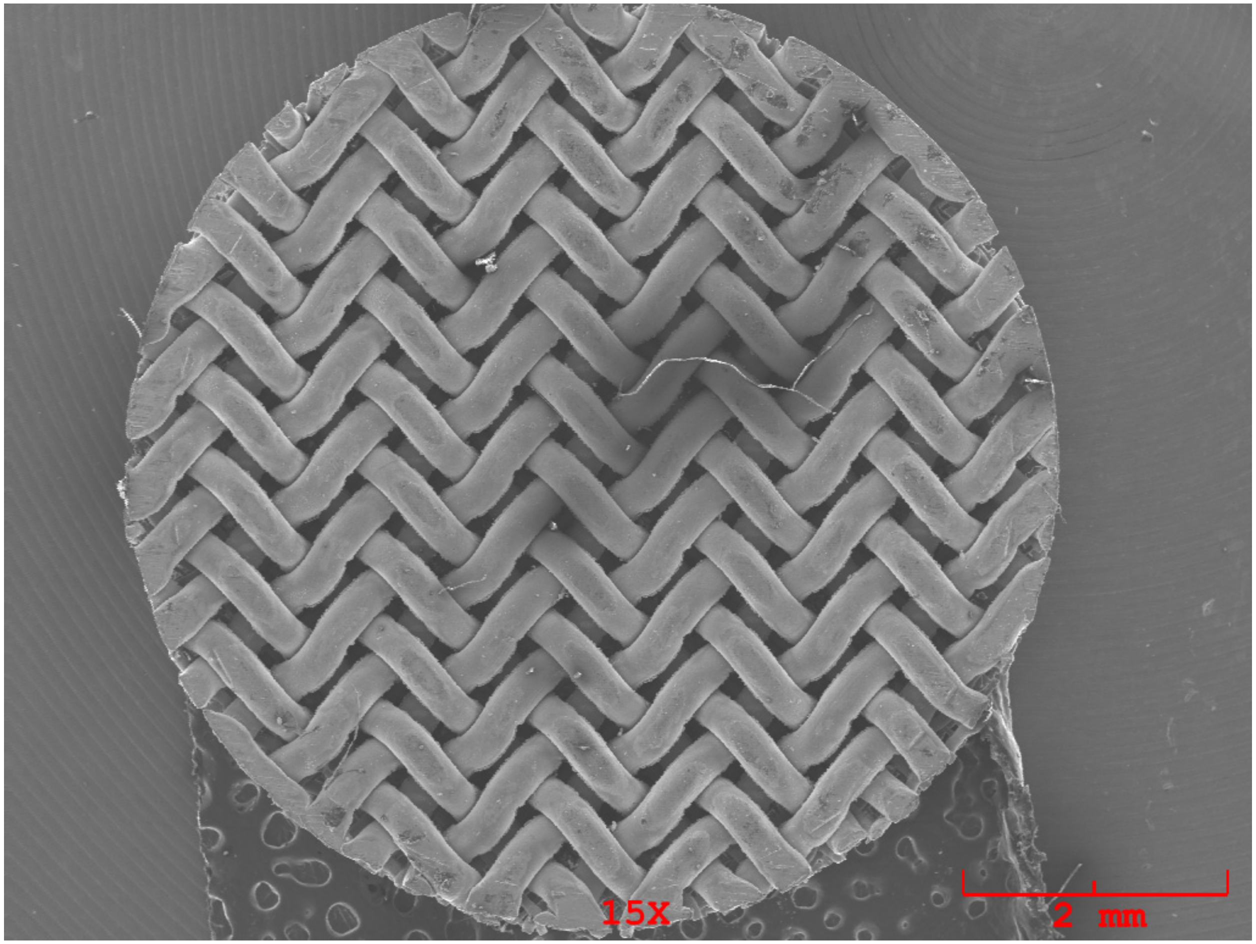
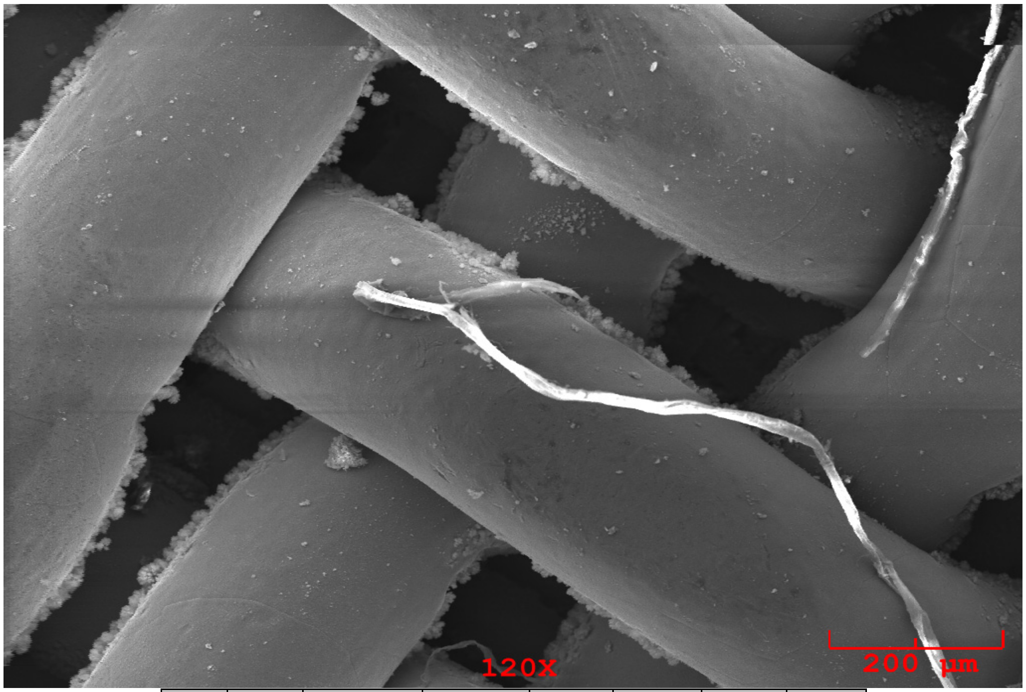


Figure L- 11 TMS Screen, Top, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	9.64	6.394	wt.%	0.567	0.597	
O	Ka	3.23	0.810	wt.%	0.157	0.196	
Al	Ka	3.04	0.472	wt.%	0.138	0.195	
Si	Ka	3.92	0.492	wt.%	0.121	0.169	
S	Ka	25.91	2.569	wt.%	0.139	0.147	
Cr	Ka	108.05	15.230	wt.%	0.319	0.195	
Mn	Ka	5.83	1.110	wt.%	0.199	0.271	
Fe	Ka	265.06	60.425	wt.%	0.769	0.310	
Ni	Ka	21.72	7.370	wt.%	0.414	0.409	
Cu	Ka	12.21	5.128	wt.%	0.417	0.454	
			100.000	wt.%			Total

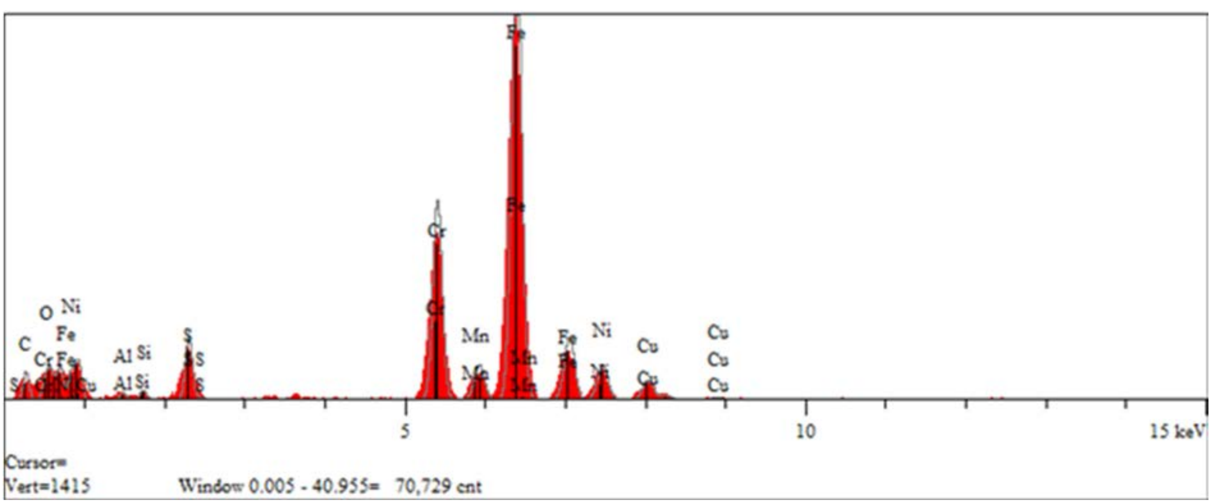


Figure L- 12 TMS Screen Top, 120X and EDX Elemental Analysis

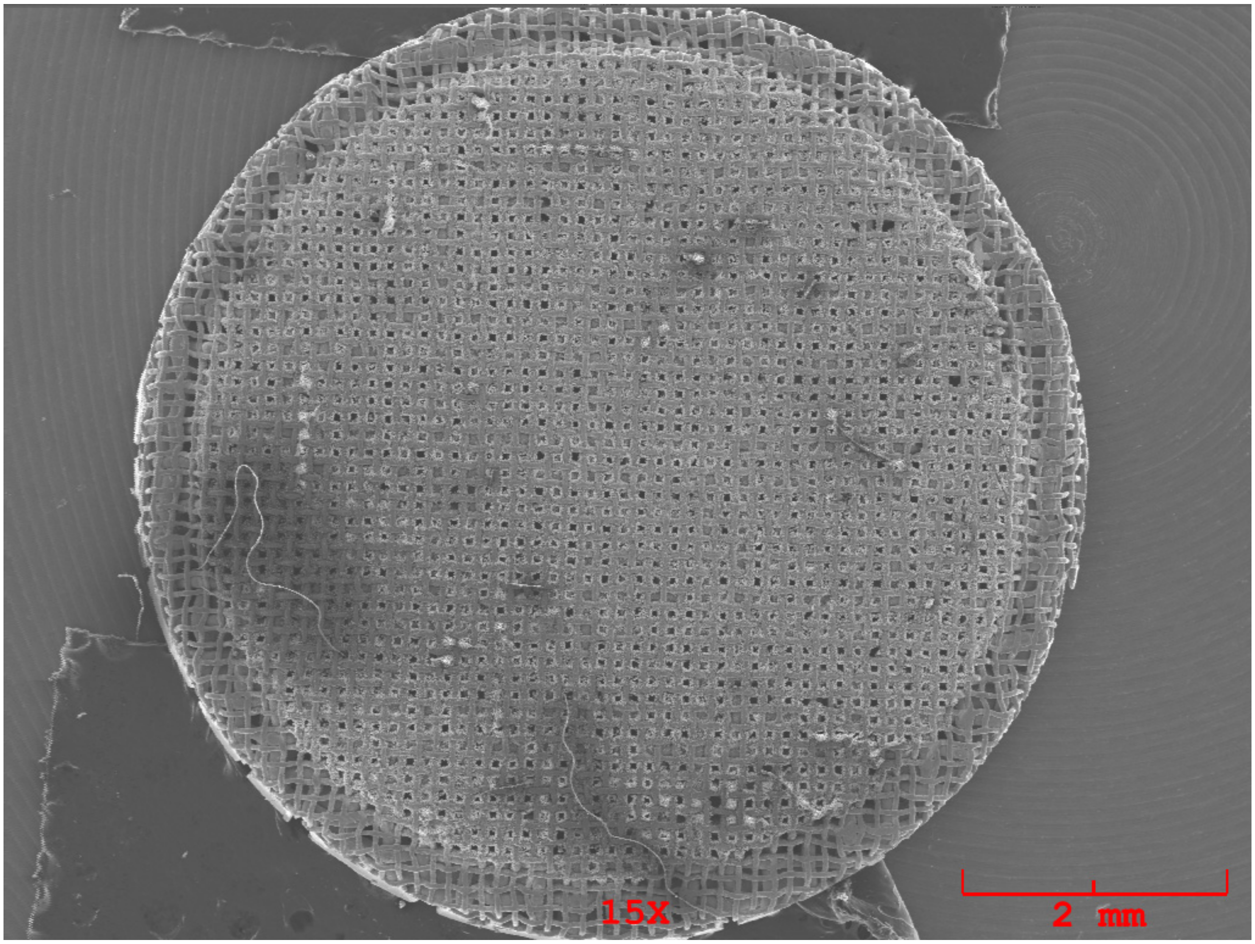
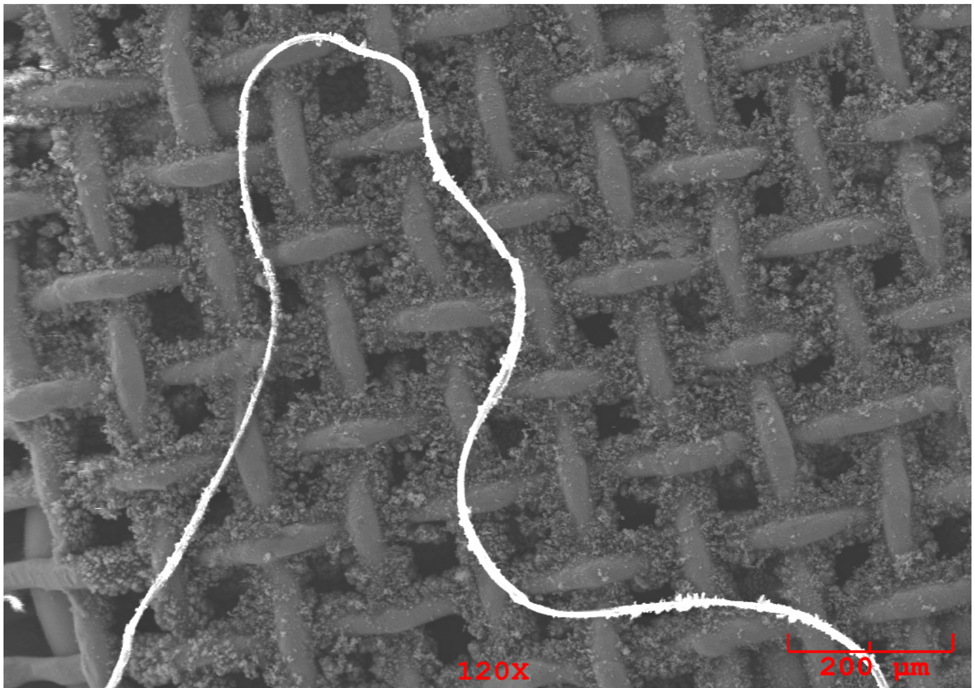


Figure L- 13 TMS Screen, Bottom, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	23.52	15.907	wt.%	0.855	0.840	
O	Ka	5.37	1.587	wt.%	0.235	0.292	
Al	Ka	6.16	0.845	wt.%	0.142	0.190	
Si	Ka	3.17	0.357	wt.%	0.116	0.166	
S	Ka	66.65	6.052	wt.%	0.176	0.144	
Cr	Ka	86.77	11.897	wt.%	0.287	0.200	
Mn	Ka	3.61	0.649	wt.%	0.187	0.266	
Fe	Ka	214.11	45.557	wt.%	0.652	0.298	
Ni	Ka	15.58	4.884	wt.%	0.347	0.373	
Cu	Ka	31.37	12.264	wt.%	0.518	0.425	
			100.000	wt.%			Total

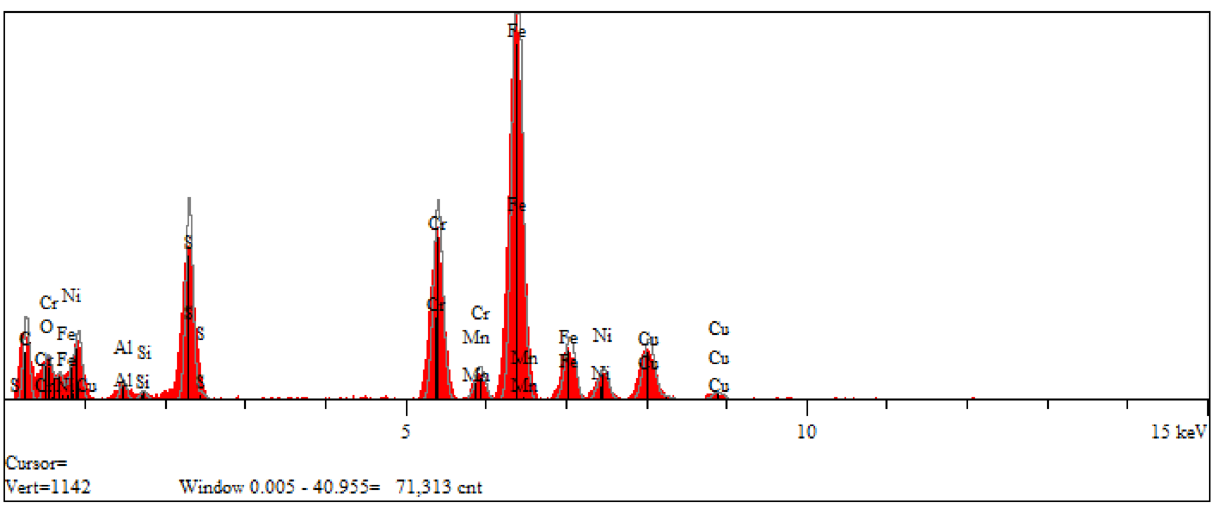


Figure L- 14 TMS Screen, Bottom, 120X and EDX Elemental Analysis

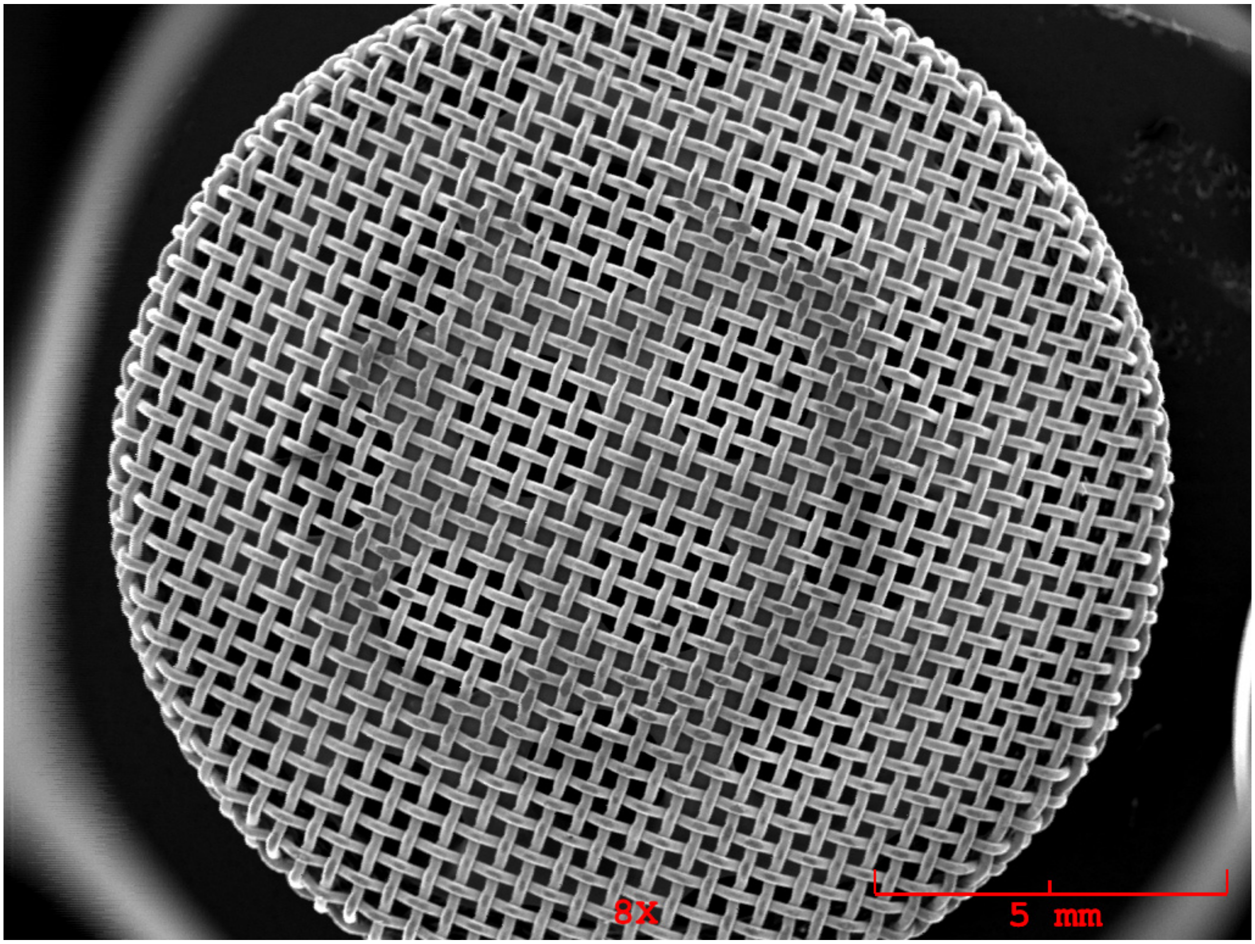
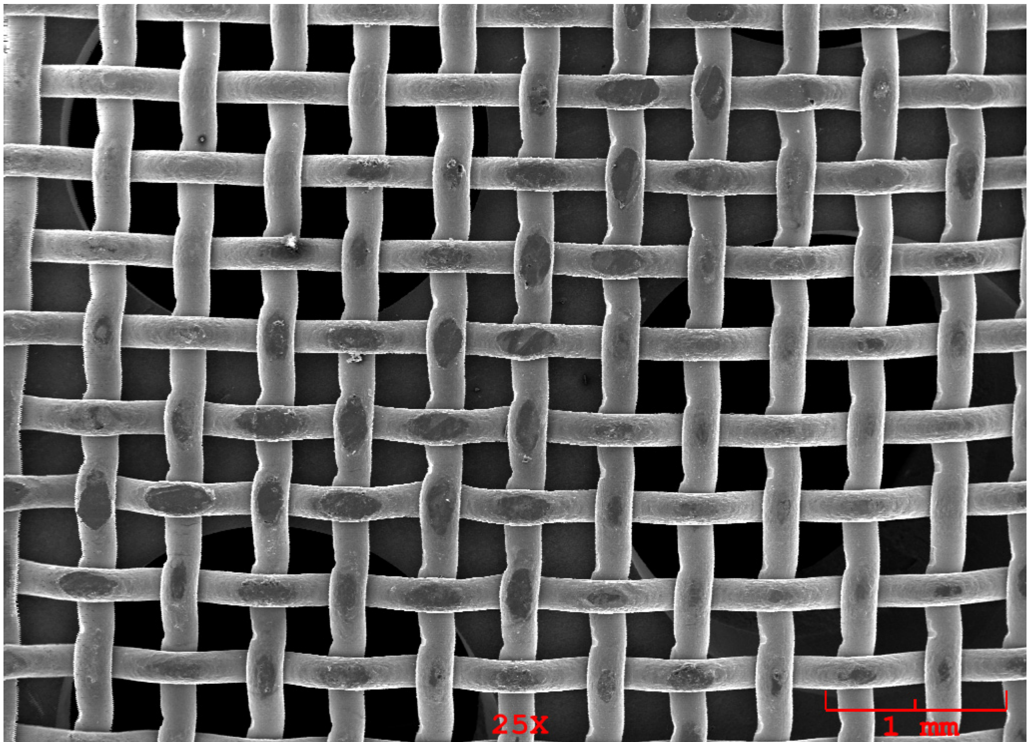


Figure L- 15 F303 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	3.16	2.365	wt.%	0.545	0.729	
Si	Ka	4.53	0.666	wt.%	0.134	0.181	
S	Ka	12.31	1.423	wt.%	0.131	0.158	
Cr	Ka	102.23	16.356	wt.%	0.350	0.203	
Mn	Ka	5.53	1.213	wt.%	0.225	0.307	
Fe	Ka	258.64	68.328	wt.%	0.882	0.362	
Ni	Ka	24.37	9.649	wt.%	0.481	0.430	
			100.000	wt.%			Total

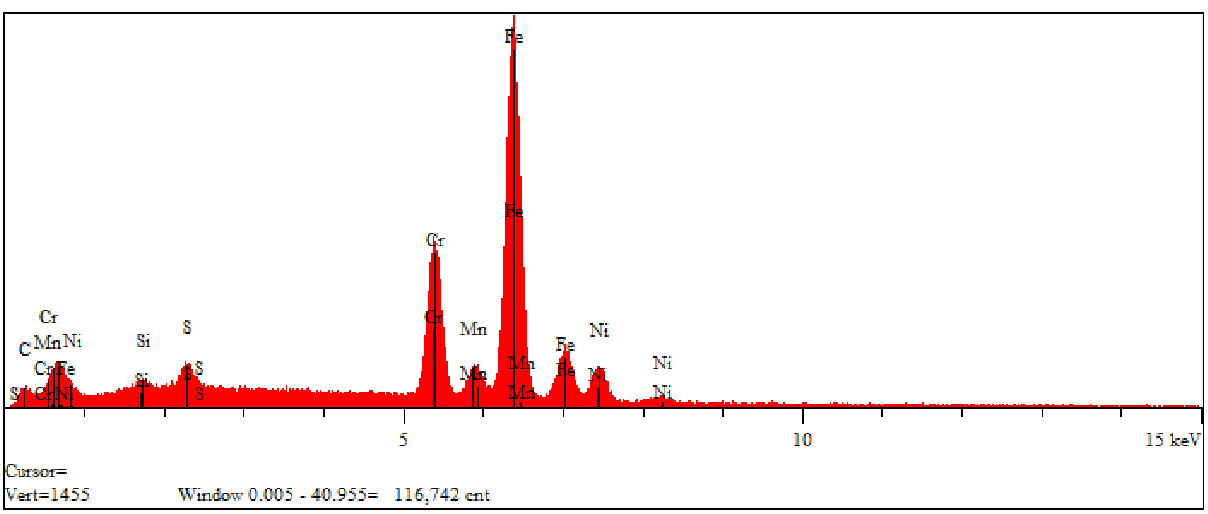


Figure L- 16 F303 Bottom 25X and EDX Elemental Analysis

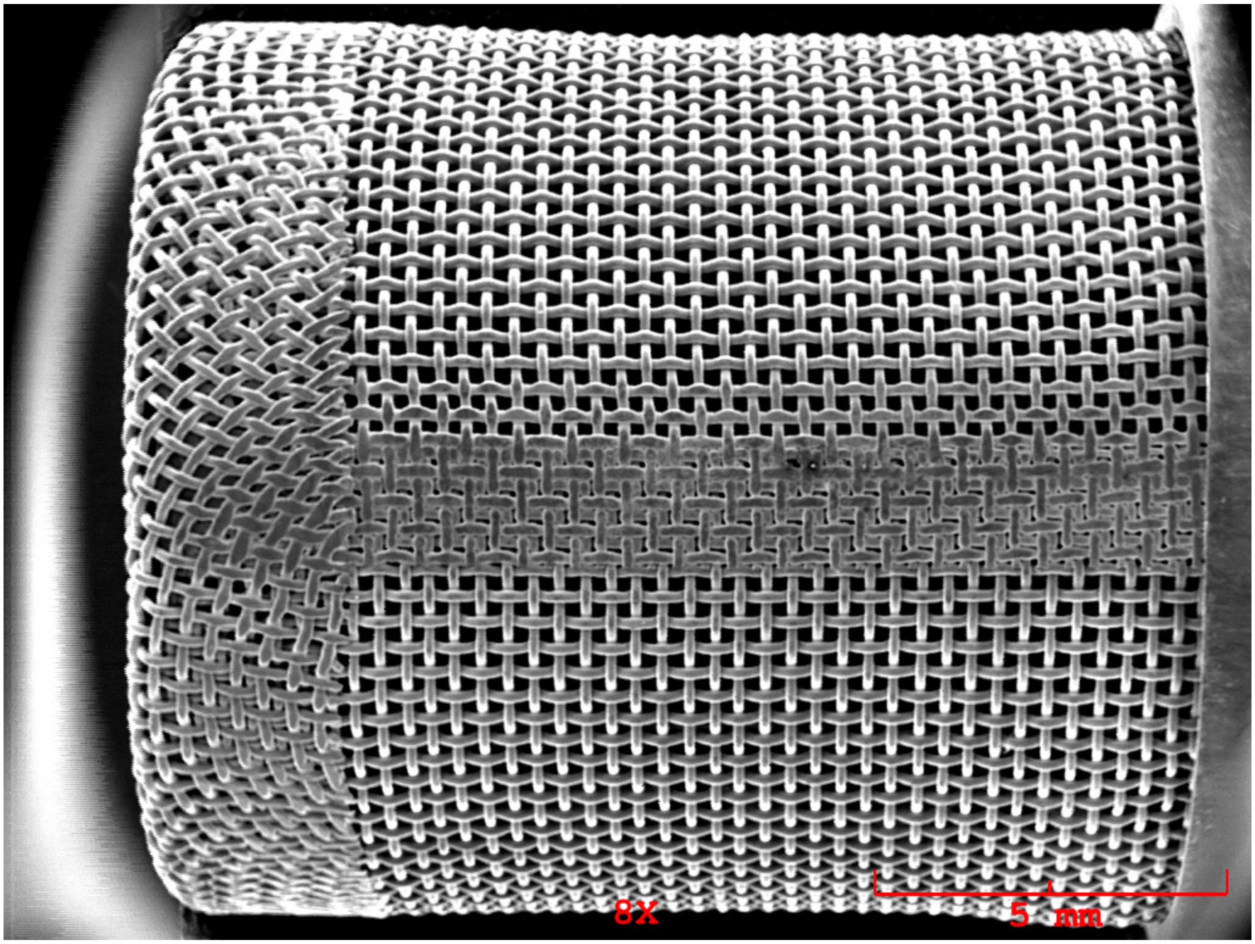
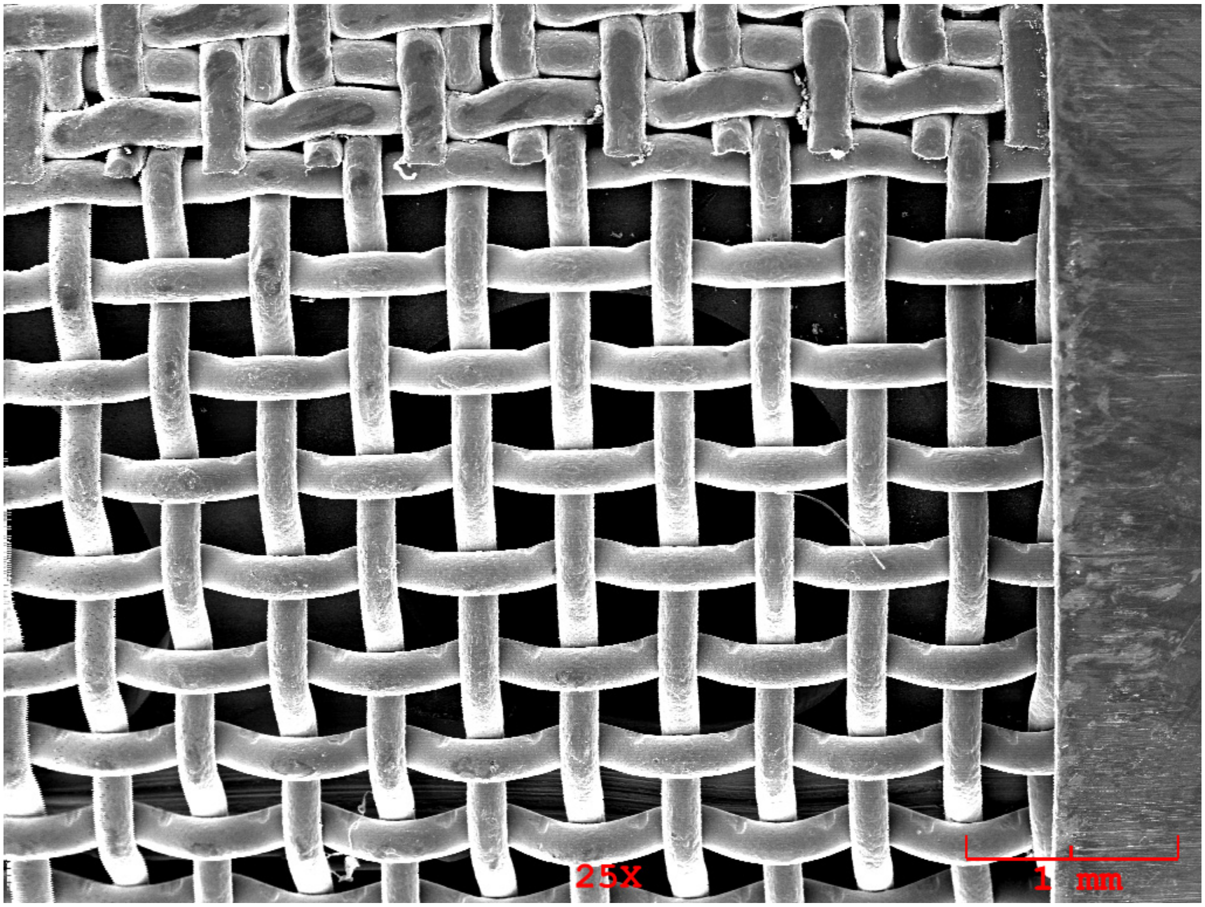


Figure L- 17 F303 Side, 8X



No Elemental or EDX Analysis Available

Figure L- 18 F303 Side 25X and EDX Elemental Analysis

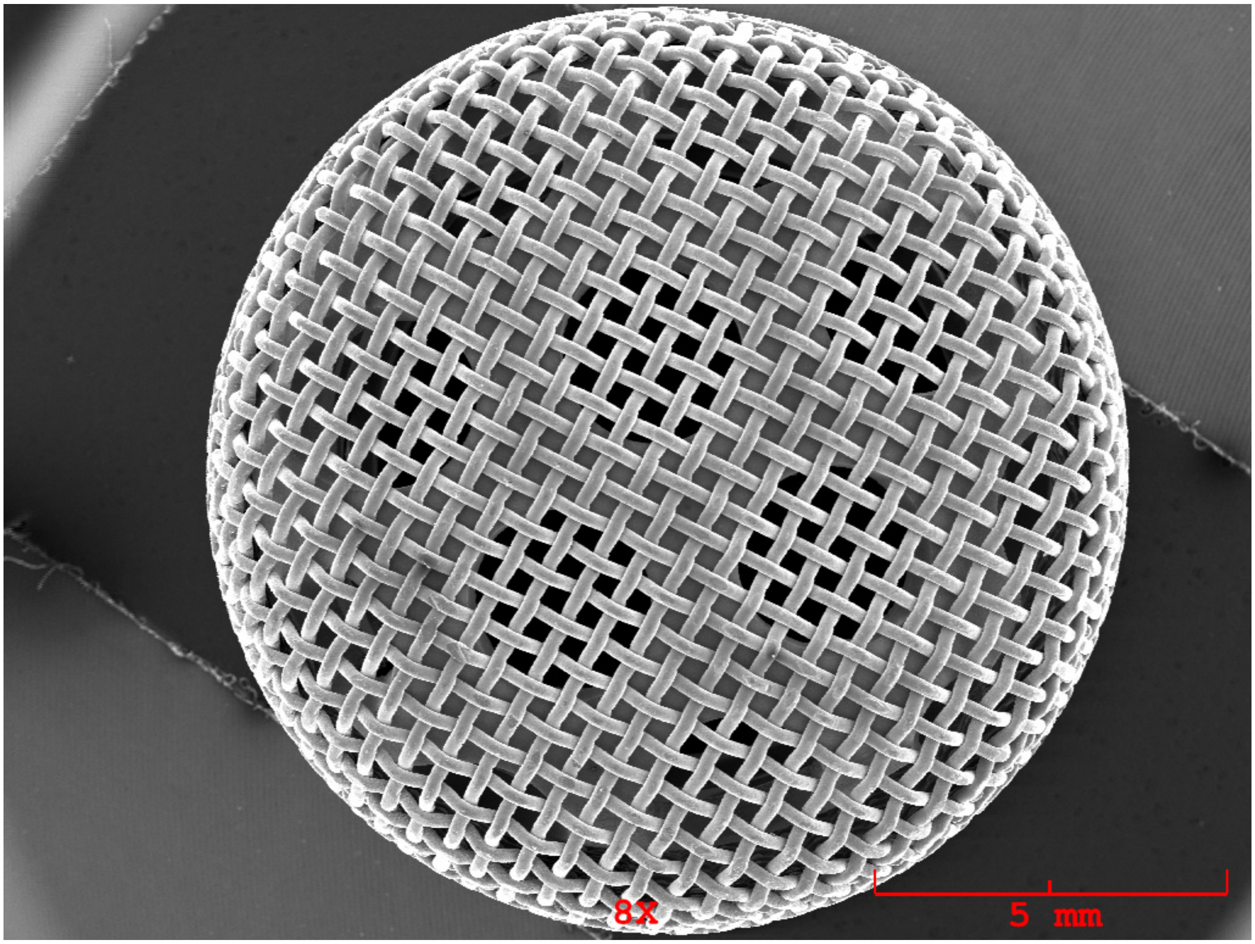
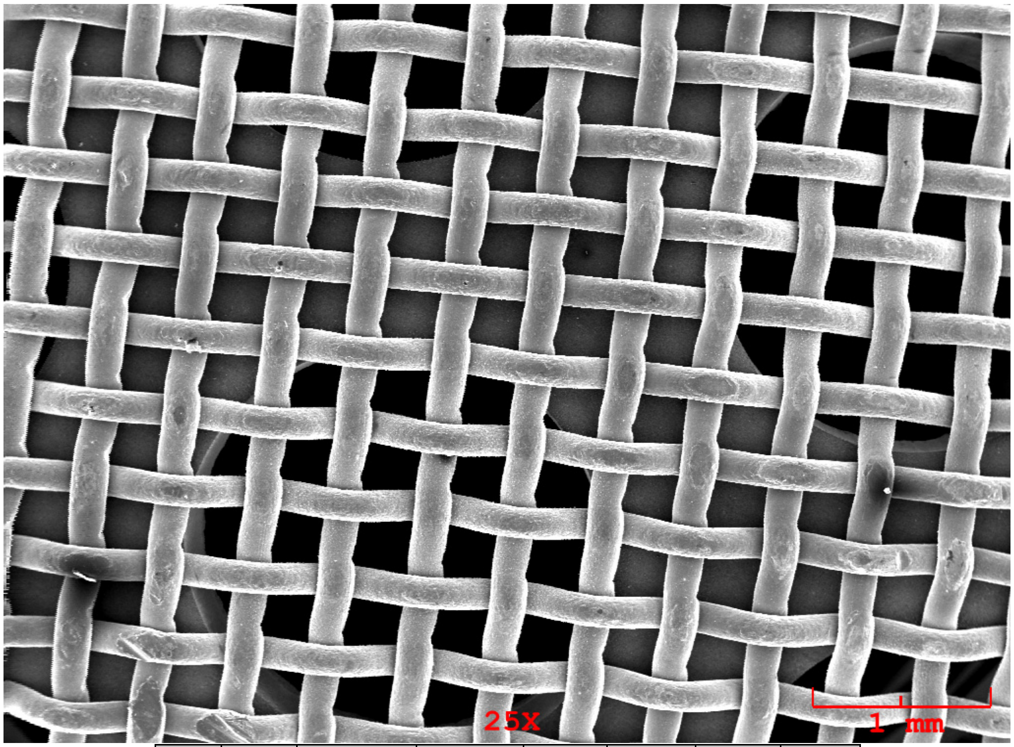


Figure L- 19 F304 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	6.93	4.343	wt.%	0.507	0.590	
Al	Ka	0.71	0.110	wt.%	0.134	0.202	
Si	Ka	3.22	0.399	wt.%	0.122	0.173	
S	Ka	16.12	1.572	wt.%	0.123	0.145	
Cr	Ka	111.10	15.005	wt.%	0.311	0.191	
Mn	Ka	7.98	1.484	wt.%	0.207	0.274	
Fe	Ka	302.29	67.631	wt.%	0.806	0.322	
Ni	Ka	28.17	9.456	wt.%	0.446	0.411	
			100.000	wt.%			Total

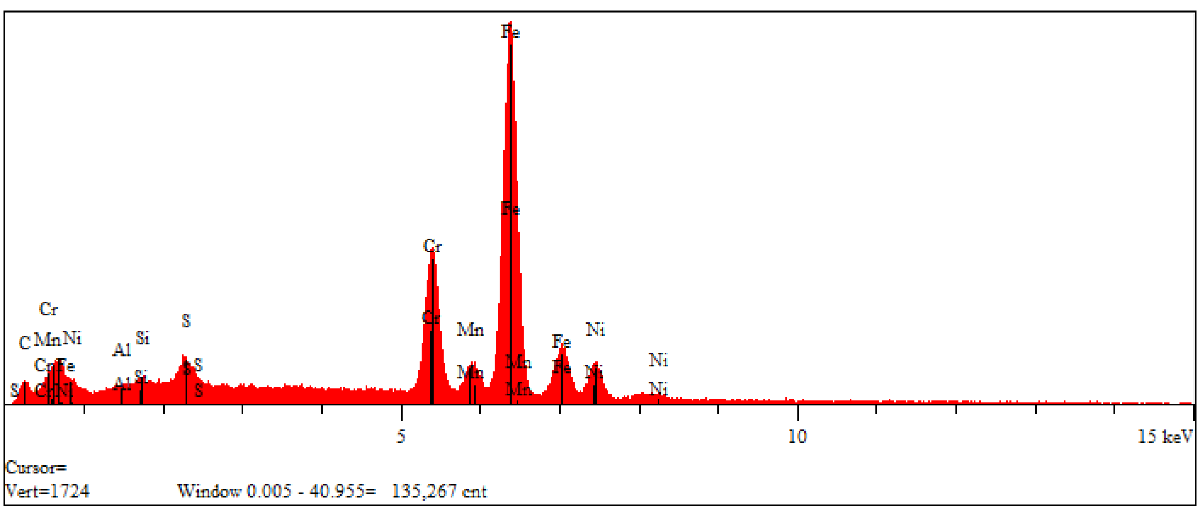


Figure L- 20 F304 Bottom, 25X and EDX Elemental Analysis

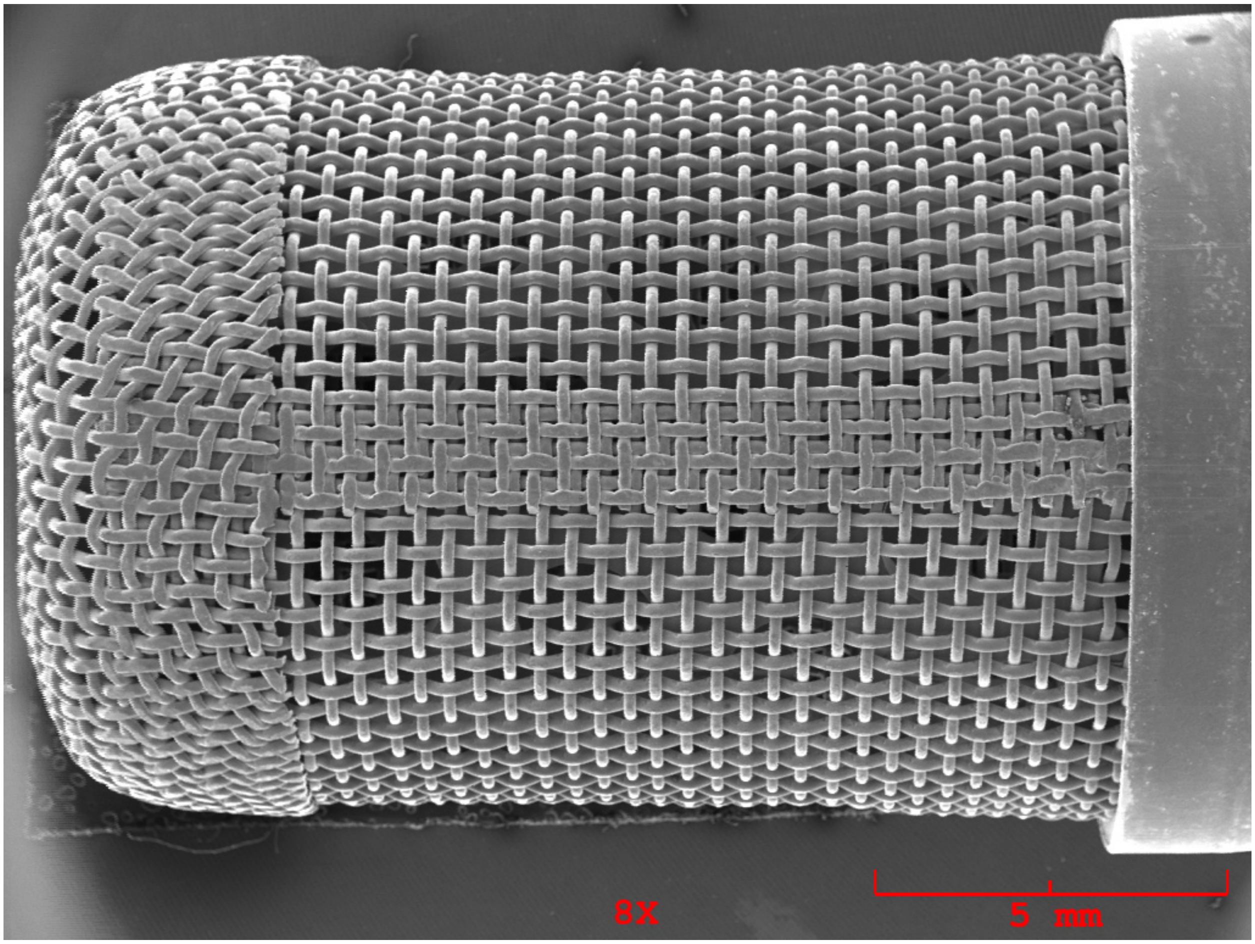
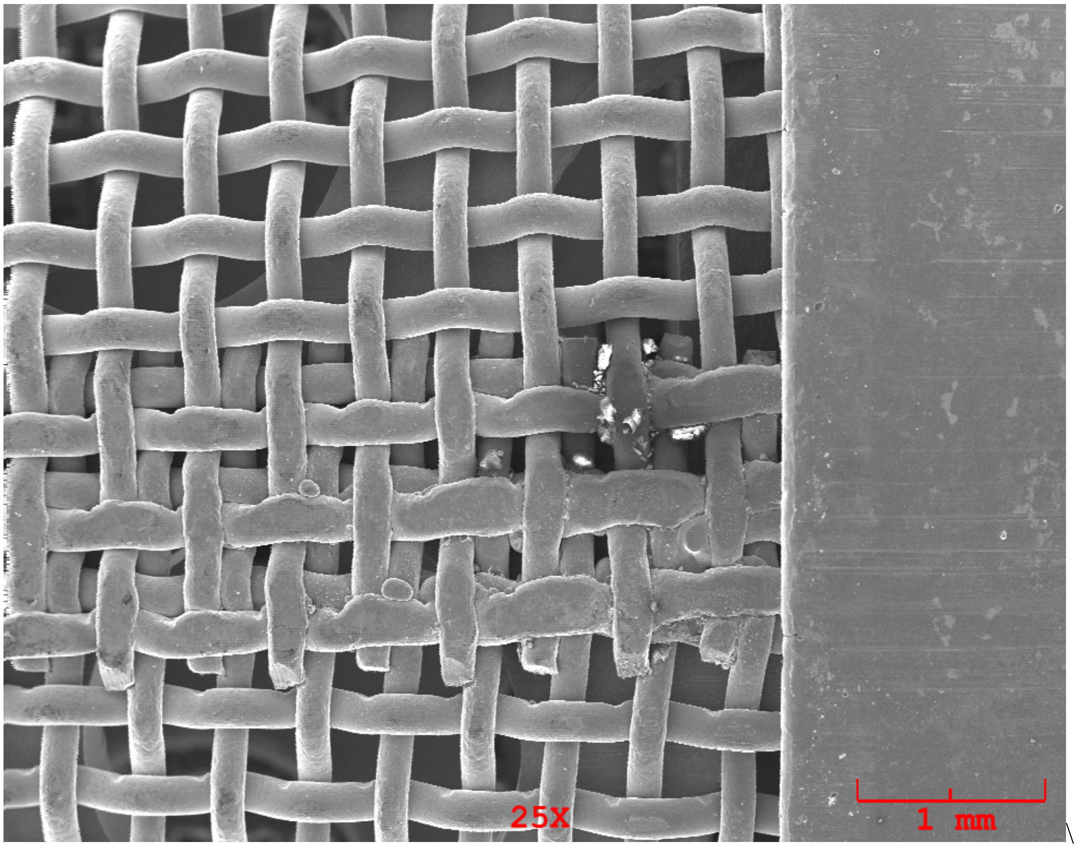


Figure L- 21 F304 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	4.11	2.362	wt.%	0.415	0.526	
S	Ka	16.24	1.458	wt.%	0.117	0.140	
Cr	Ka	127.07	15.694	wt.%	0.303	0.183	
Mn	Ka	7.72	1.316	wt.%	0.196	0.263	
Fe	Ka	339.07	69.613	wt.%	0.782	0.304	
Ni	Ka	30.99	9.556	wt.%	0.436	0.413	
			100.000	wt.%			Total

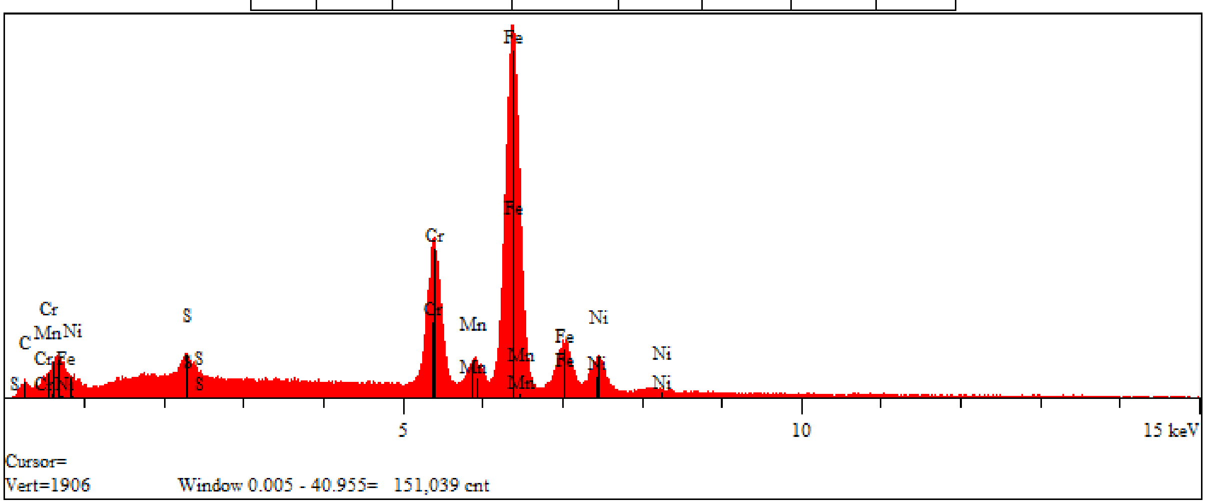


Figure L- 22 F304 Side, 25X and EDX Elemental Analysis

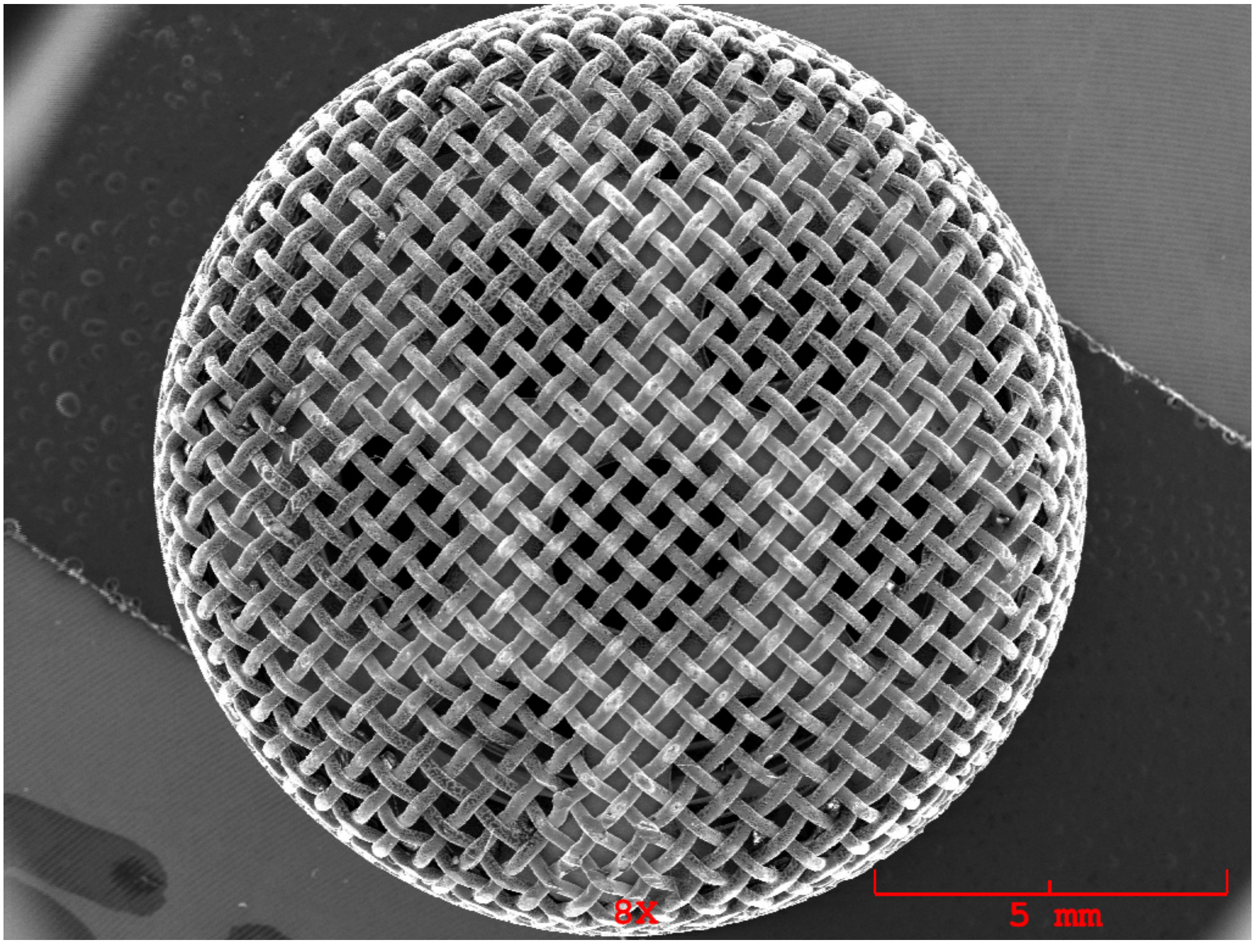
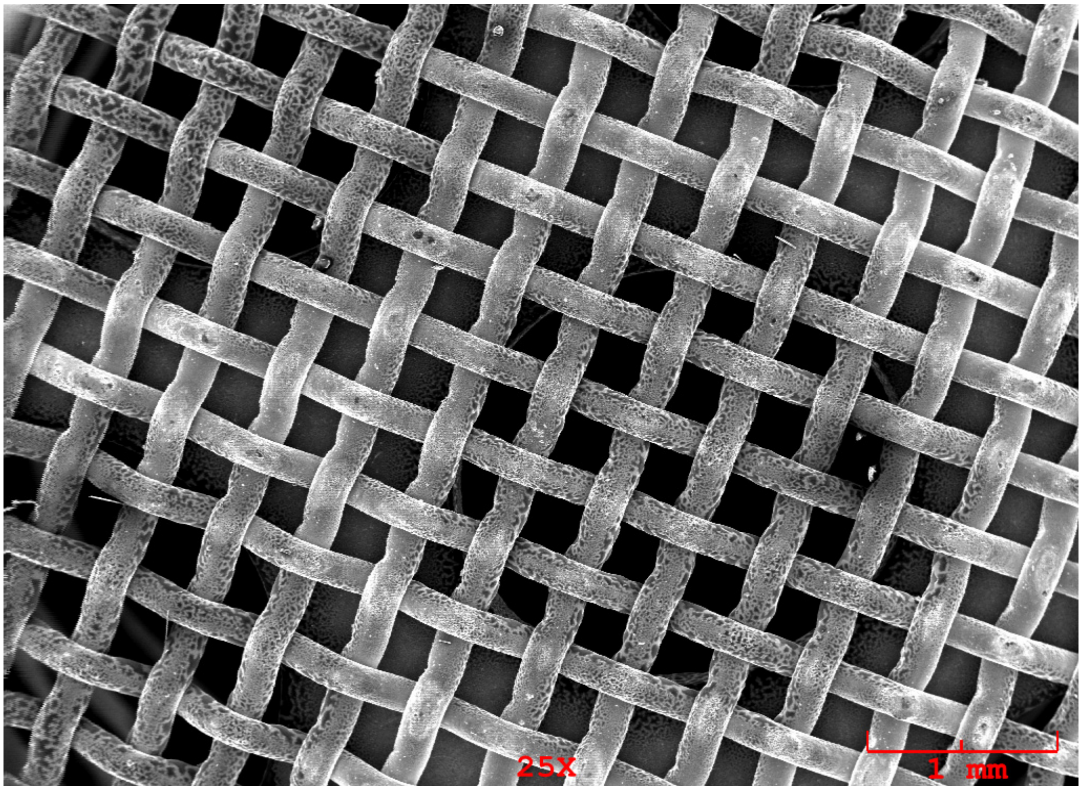


Figure L- 23 F702 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	15.62	14.440	wt.%	0.968	0.971	
O	Ka	1.27	0.528	wt.%	0.236	0.331	
Al	Ka	0.96	0.200	wt.%	0.153	0.225	
Si	Ka	2.76	0.466	wt.%	0.139	0.195	
S	Ka	30.36	4.157	wt.%	0.187	0.168	
Cr	Ka	65.73	13.224	wt.%	0.359	0.228	
Mn	Ka	3.85	1.053	wt.%	0.234	0.318	
Fe	Ka	178.75	58.585	wt.%	0.911	0.383	
Ni	Ka	15.11	7.346	wt.%	0.492	0.483	
			100.000	wt.%			Total

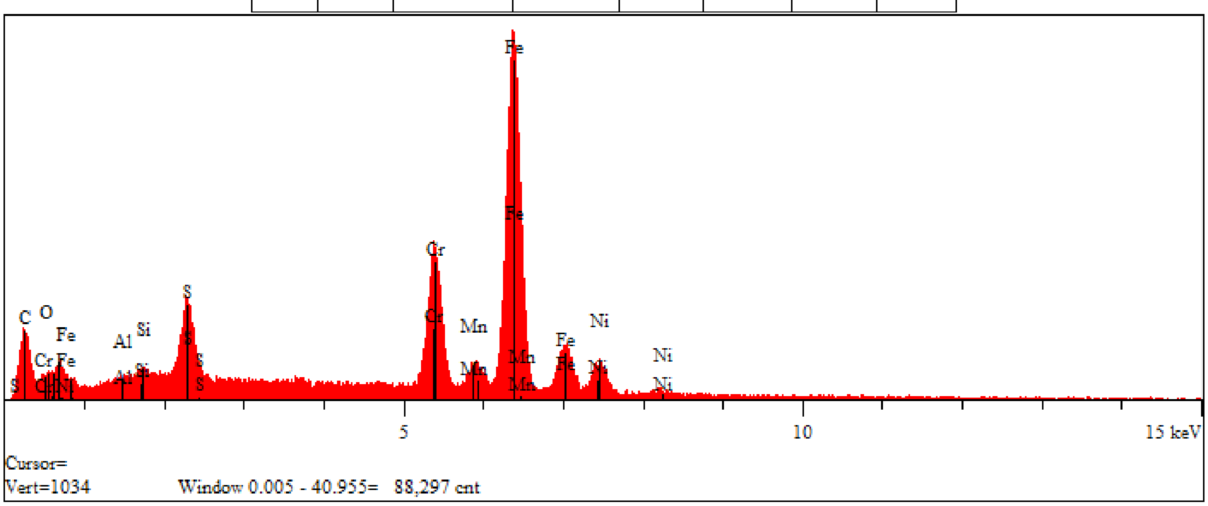


Figure L- 24 F702 Bottom, 25X and EDX Elemental Analysis

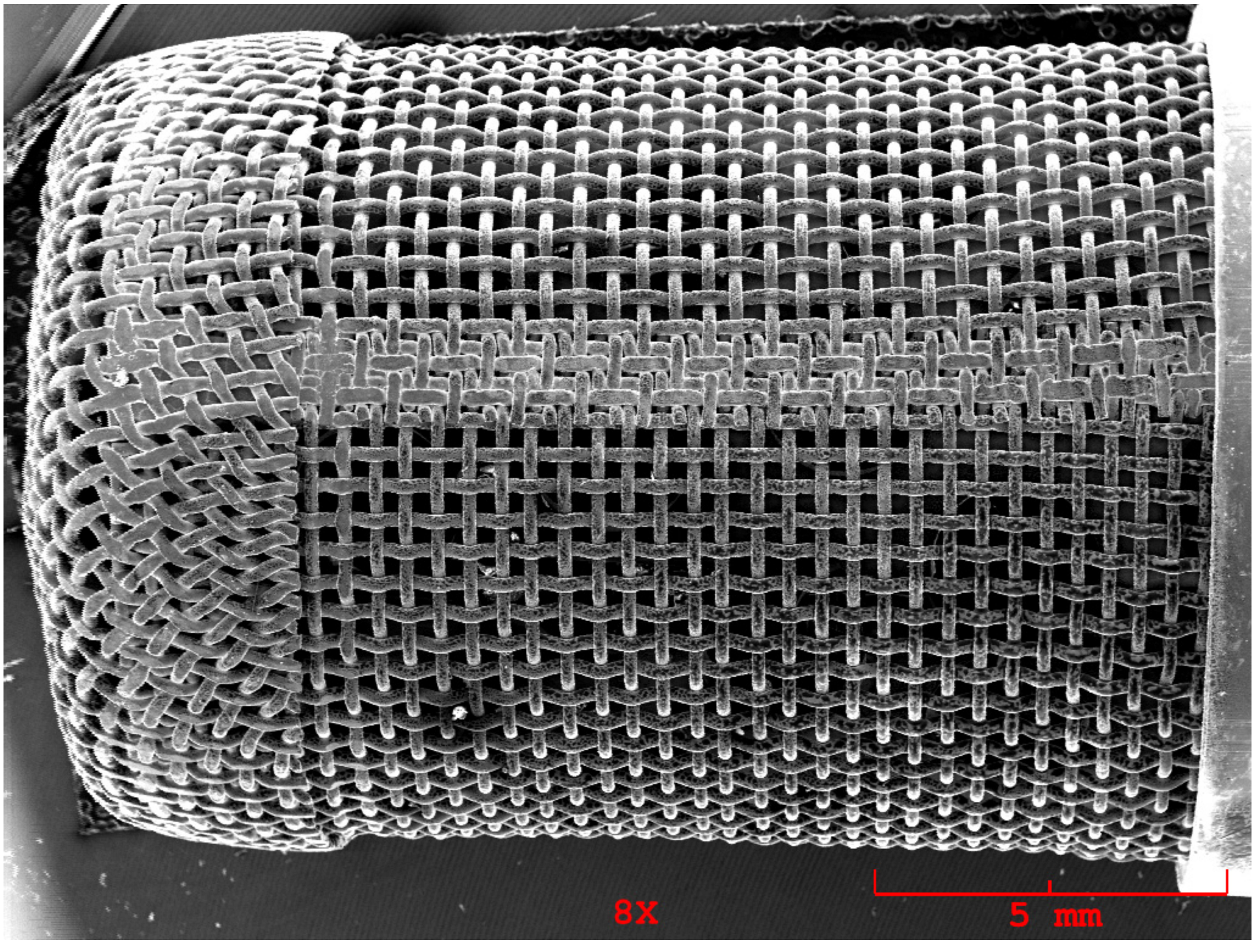
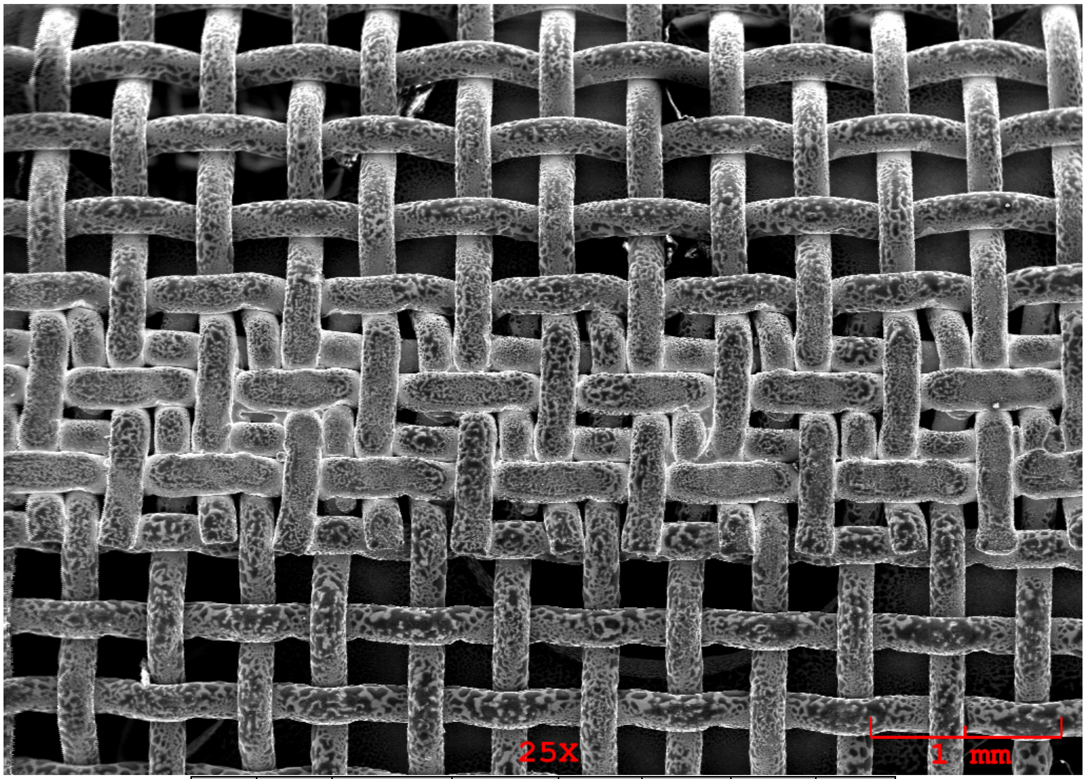


Figure L- 25 F702 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	23.06	15.294	wt.%	0.841	0.839	
Si	Ka	2.59	0.315	wt.%	0.121	0.175	
S	Ka	42.90	4.234	wt.%	0.162	0.150	
Cr	Ka	94.27	13.741	wt.%	0.313	0.204	
Mn	Ka	3.77	0.745	wt.%	0.203	0.288	
Fe	Ka	244.40	57.908	wt.%	0.772	0.334	
Ni	Ka	22.10	7.762	wt.%	0.425	0.409	
			100.000	wt.%			Total

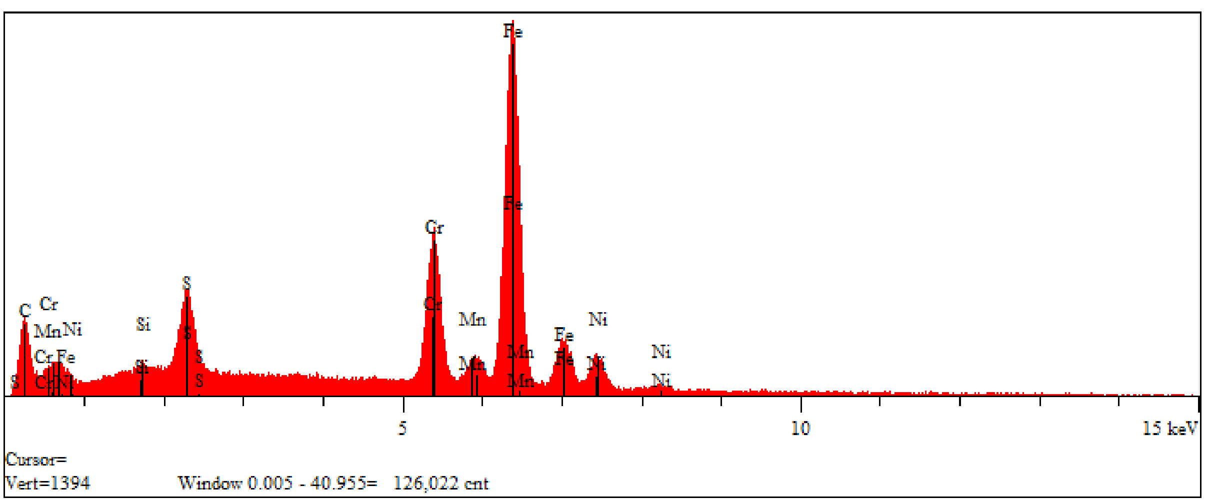


Figure L-26F702 Side, 25X and EDX Elemental Analysis

APPENDIX M - RUN 158 DATA PACKAGE

Run Conditions: EDTST Mode, MT Conditions
Fuel ID: POSF-12843, Ft McCoy
Airframe Heat Exchanger Bulk Fuel Output: 285 °F
HP Pump HX Out/FCOC Bulk Fuel In: 325 °F
Fuel-Cooled Oil Cooler Bulk Fuel Output: 350 °F
Burner Feed Arm Max Wetted Wall Temperature: 510 °F
Run Duration: 72 Hours

DATA SUMMARY

Run 158; Run Type: EDTST; Op Mode: MT; MSNs: N/A; EDTST Run Hours: 72 Fuel ID#: POSF12843; Run Tank: S-3; Run Type: EDTST; Op Mode: MT Fuel Type: F-24; Additive(s): None AFHX Out: 285 °F; FCOC In: 325 °F; FCOC Out: 350 °F; BFA MWWT: 510 °F;

Component/Device	Serial No.	Pre-Test %	Post-Test %	Spread (Pre/Post Delta), %	Shift, PPH	Skew, PSID	Flow Range Shift, PPH	Flow Midpoint Shift, PPH	Overall Rating	Hysteresis Area Change (PPH-DP)
FDV	1171	0.0	0.2	0.2	-1.2	0.7	-4.6	-2.3	Minor+	1
Servo2	010	7.3	275.0	267.7	-15.7	0.0	-0.5	-0.3	Non-Funct	2057

Effective Carbon - µgrams

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	49.6	59.2	58.7	60.1	58.5					
BFA	117.0	465.3	1144.1	2869.1	3806.2	6422.9	8103.7	8121.8	5564.4	4358.6
Total FCOC Carbon, µgrams	286.0	µgrams	0.3	mgrams						
Total BFA Carbon, µgrams	40973.0	µgrams	41.0	mgrams						

SCREENS	Total Carbon, µg	Background Carbon, µg	Effective Carbon, µg	MWWT Start	MWWT End	Delta BFA MWWT	TE	BFA AWWT Start	BFA AWWT End	Delta BFA AWWT
TMS	53.3	0.3	52.9	510.54	551.00	42.73	MAX	491.68	530.45	38.77
F303	154.2	25.4	128.8	502.76	529.20	26.44	TE325	SV Inlet (TE702)	FDV Inlet (TE313)	BFA Inlet (TE316)
F304	189.6	12.9	176.7	510.54	550.65	40.11	TE324			
F305	0.0	0.0	0.0	508.27	551.00	42.73	TE323	342	328	326
F702	376.3	12.9	363.4	509.34	548.62	39.28	TE322			

Effective Carbon Deposition - µgrams/cm^2

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	13.6	16.2	16.1	16.5	16.0					
BFA	67.9	270.1	664.1	1665.3	2209.3	3728.2	4703.8	4714.3	3229.8	2530.0

TMS Mass Change - grams

Component/Device	Tare, g	Mass, g	Mass Gain, g
TMS	0.08662	0.08684	0.00022
F303	7.09982	7.10031	0.00049
F304	3.06415	3.06495	0.00080
F305	0.00000	0.00000	0.00000
F702	3.05677	3.05840	0.00163

Hysteresis Ratings:

- NONE: indicating that the pre-test and post-test hysteresis curves, for all intents and purposes, are nearly indistinguishable from one another. Minor differences may be seen between the pre-test and post-test curves but these are very small.
- Minor: There are small differences between per- and post-test curves. The spread for these curves is typically within 5% of one another. There may be some small changes in shift and skew for the valve. This degree of hysteresis would not be expected to alter the functional nature of the valve.
- Moderate: There are definite differences between pre-and post-test curves. There may be definite differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically between 5% and 15%. This degree of hysteresis might be expected to alter the functional nature of the valve.
- Severe: There are pronounce differences between pre-and post-test curves. There may be pronounced differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically in excess 15%. This degree of hysteresis would be considered out-of-spec for the valve.
- Non-Functional: There are major differences between pre-and post-test curves. There may be major differences in shift and skew as well. The hysteresis curve will exhibit flat segments (either vertically or horizontally). Shift and skew have majorly changed the performance envelope of the valve. This degree of hysteresis would cause the valve to be non-functional or unresponsive over small or large portions of the performance range of the valve.

Figure M - 1 Run 158 Data Summary

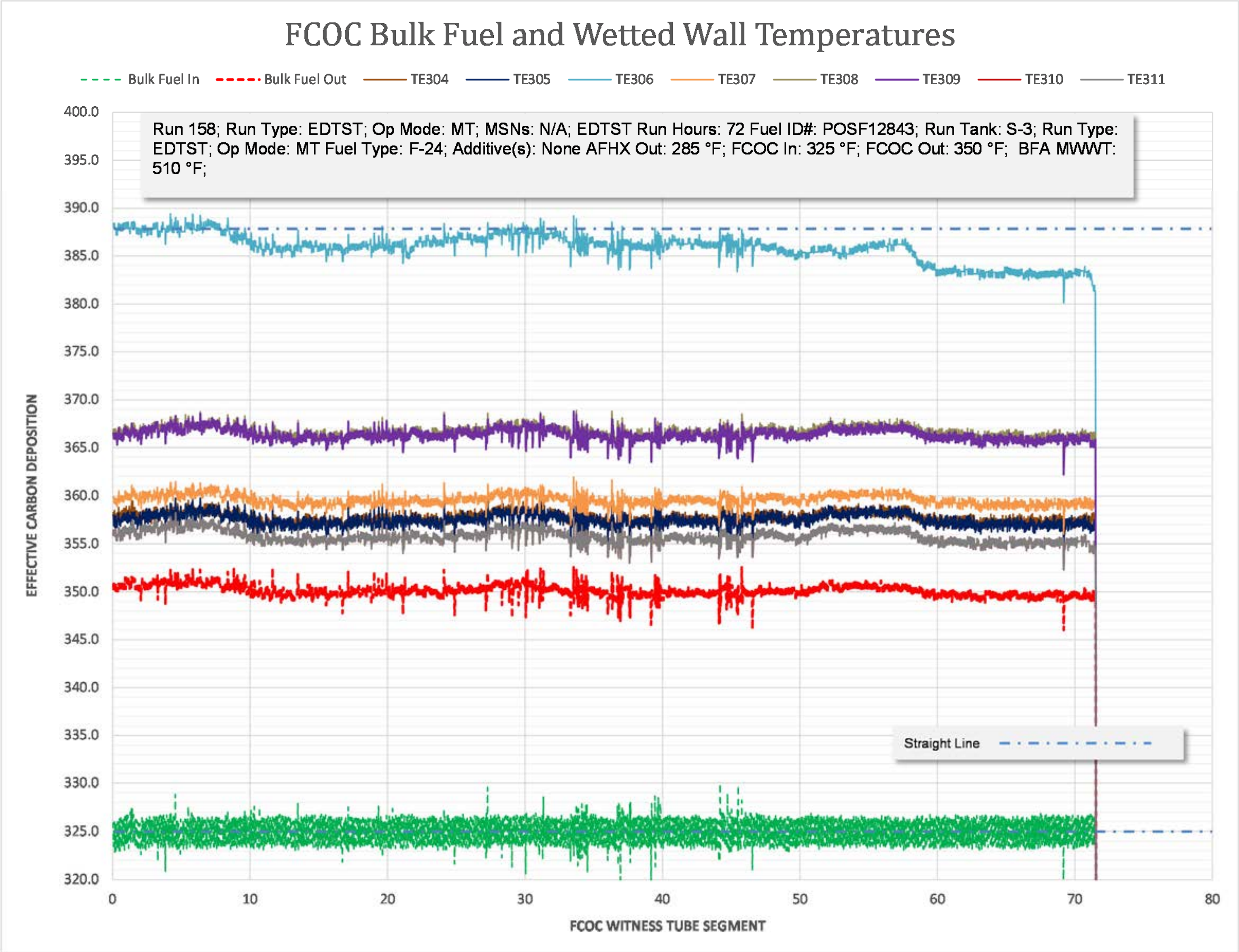


Figure M - 2 FCOC Bulk Fuel and Wetted Wall Temperatures

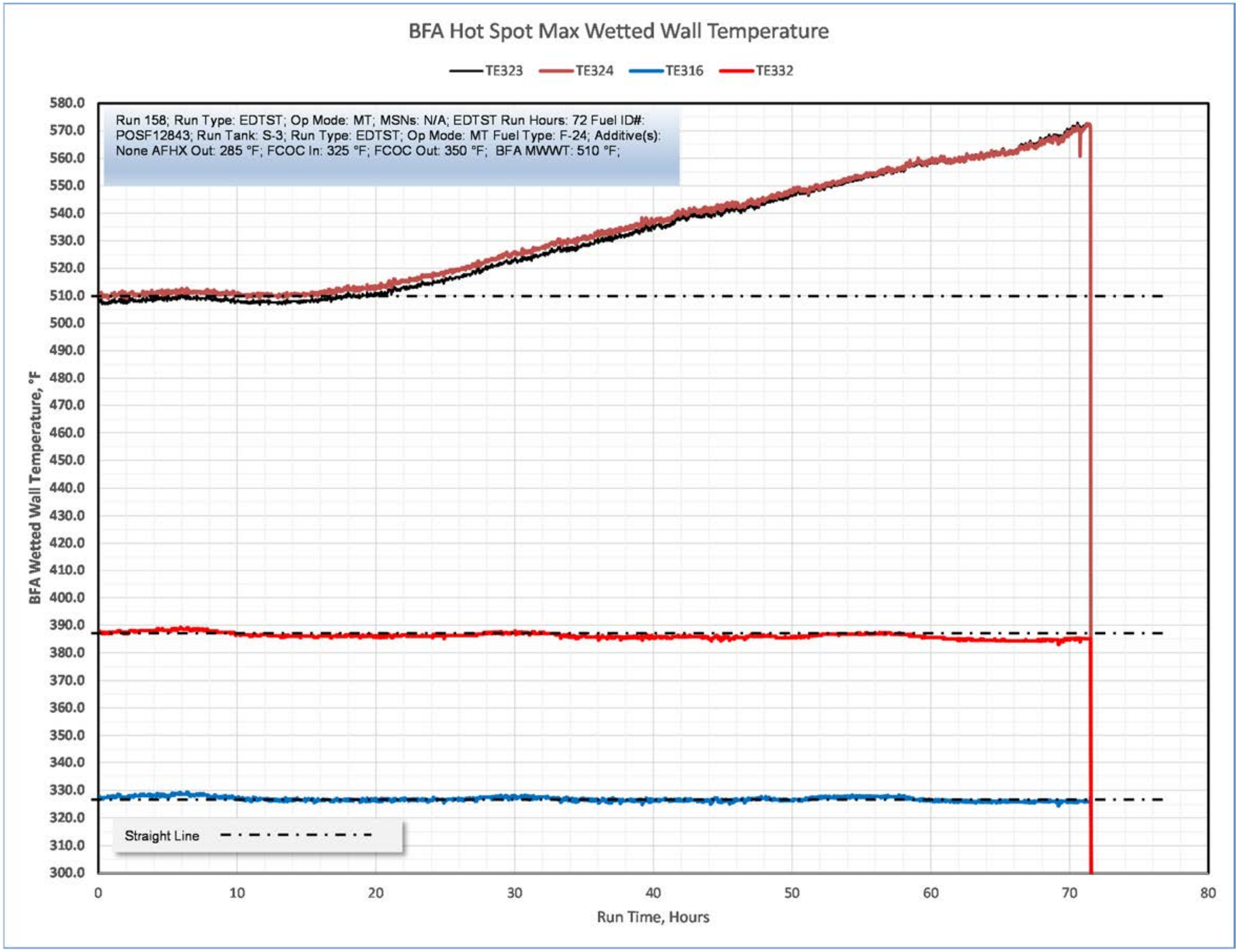


Figure M - 3 BFA Hot Spot Max Wetted Wall And Bulk Fuel Temperatures

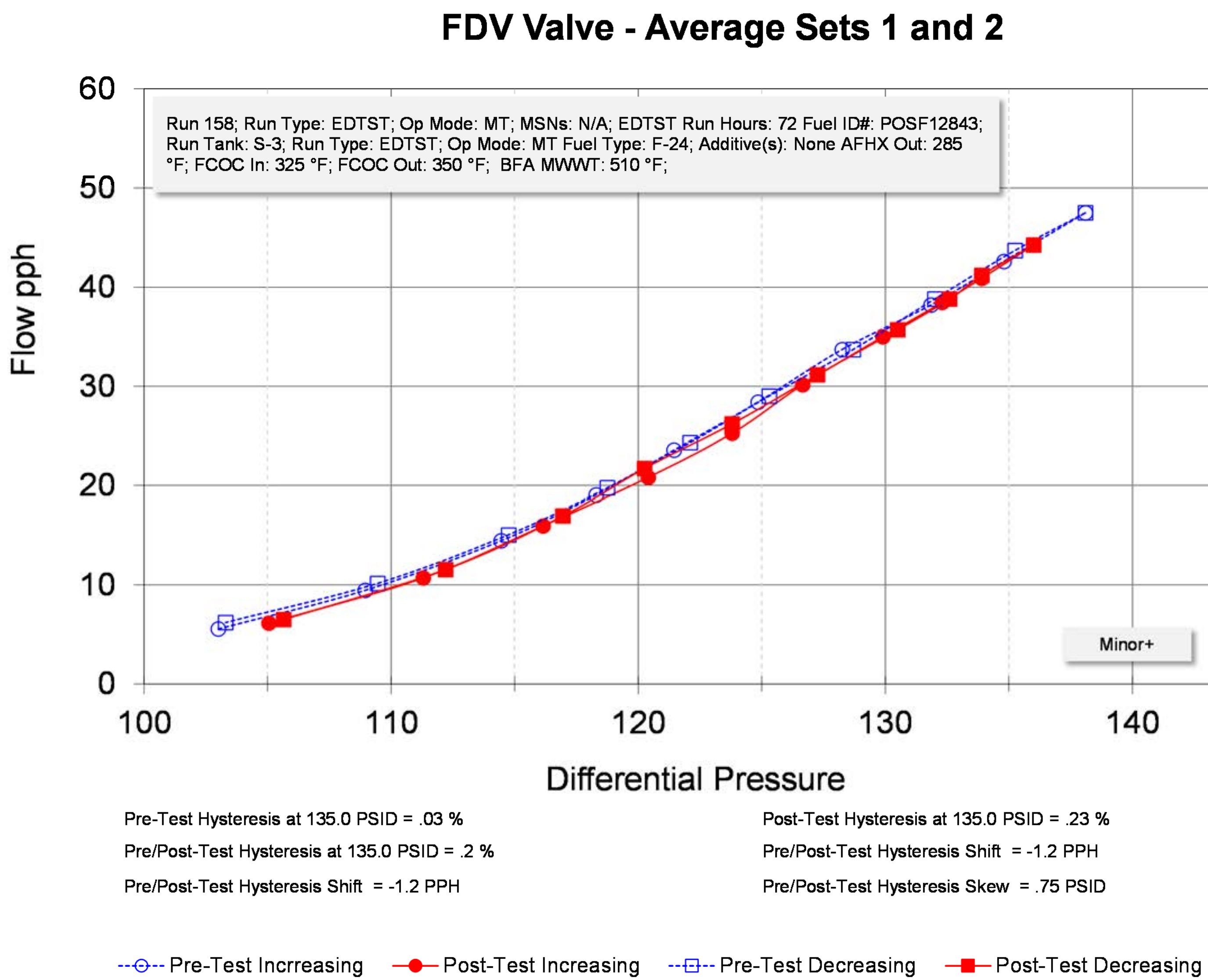


Figure M - 4 FDV Hysteresis

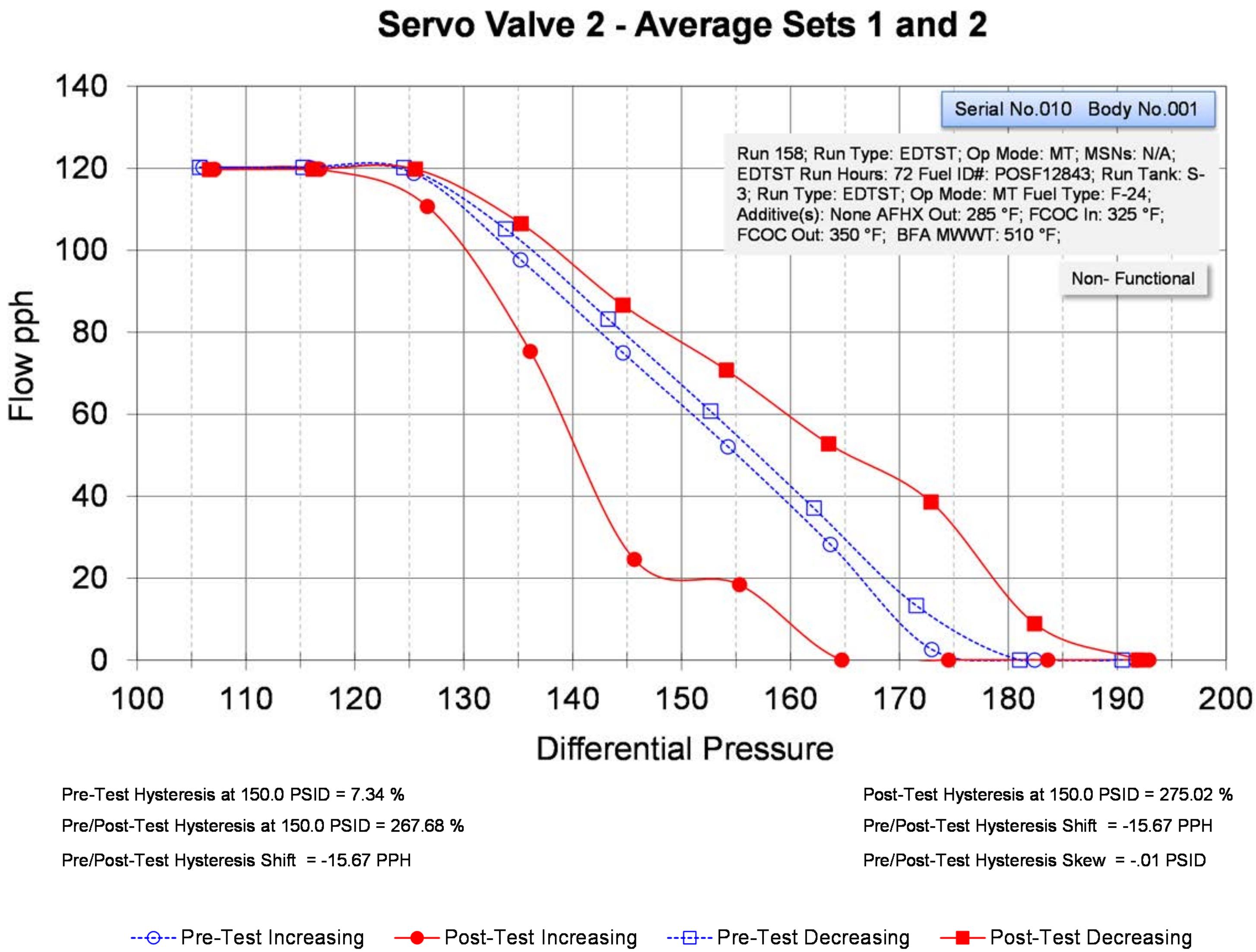


Figure M - 5 Servo Valve Hysteresis

Flow Divider Valve Components – Run 158

Run 158 POSF-12843 MT

20

Figure M - 6 FDV Components - Comparison to Clean

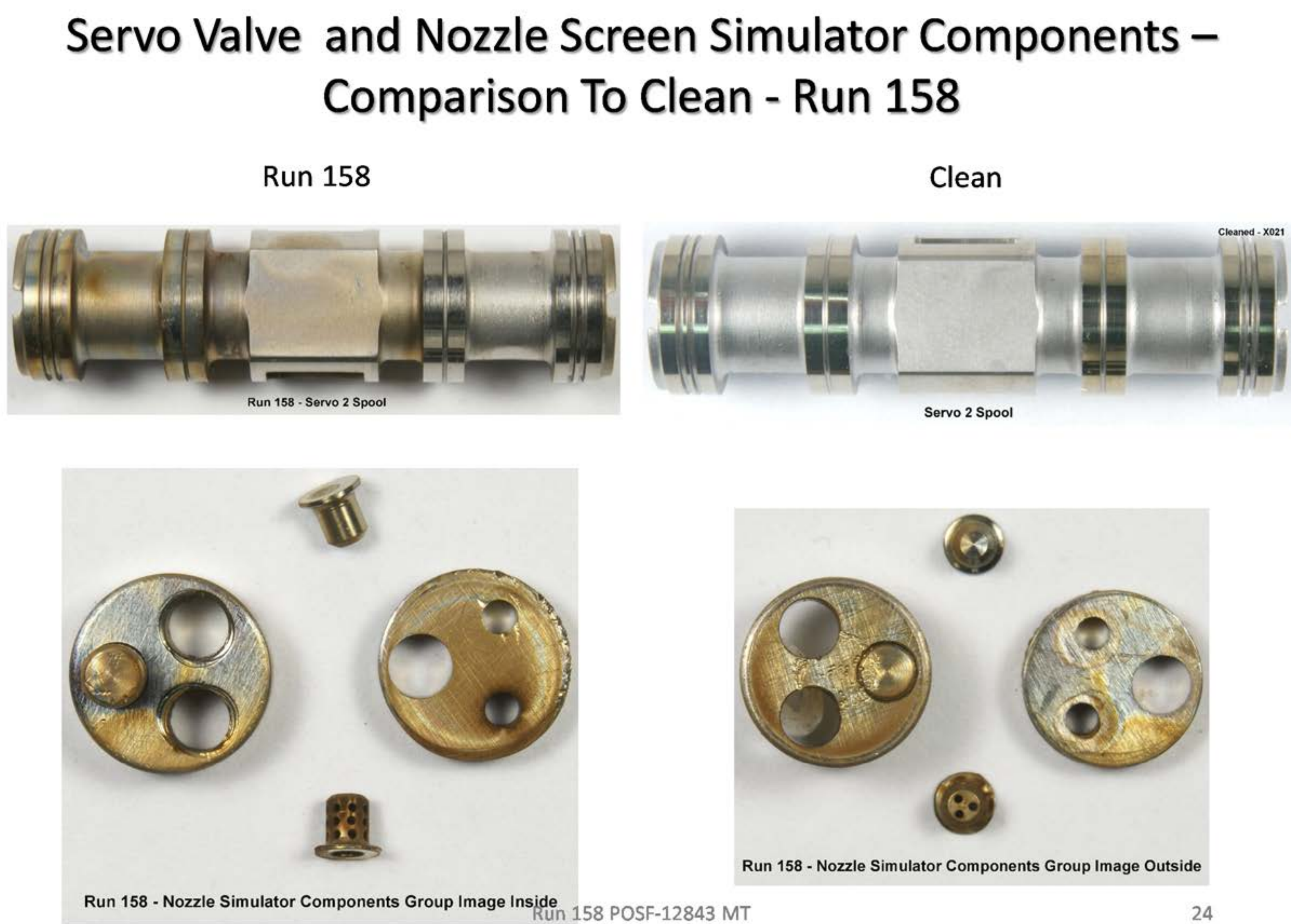


Figure M - 7 Servo Valve and Nozzle Screen Components - Comparison to Clean

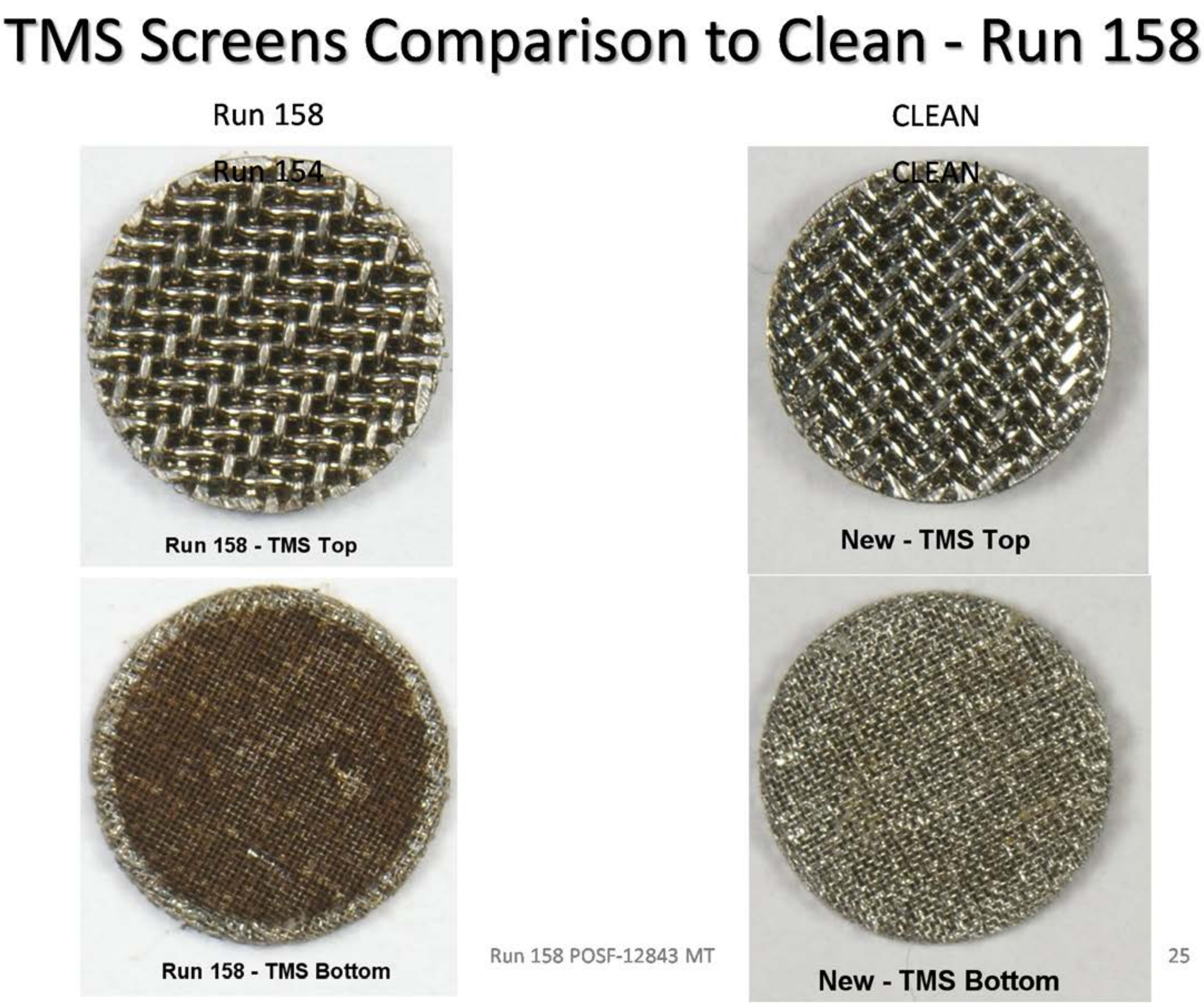


Figure M - 8 TMS Screen Top and Bottom - Comparison to Clean

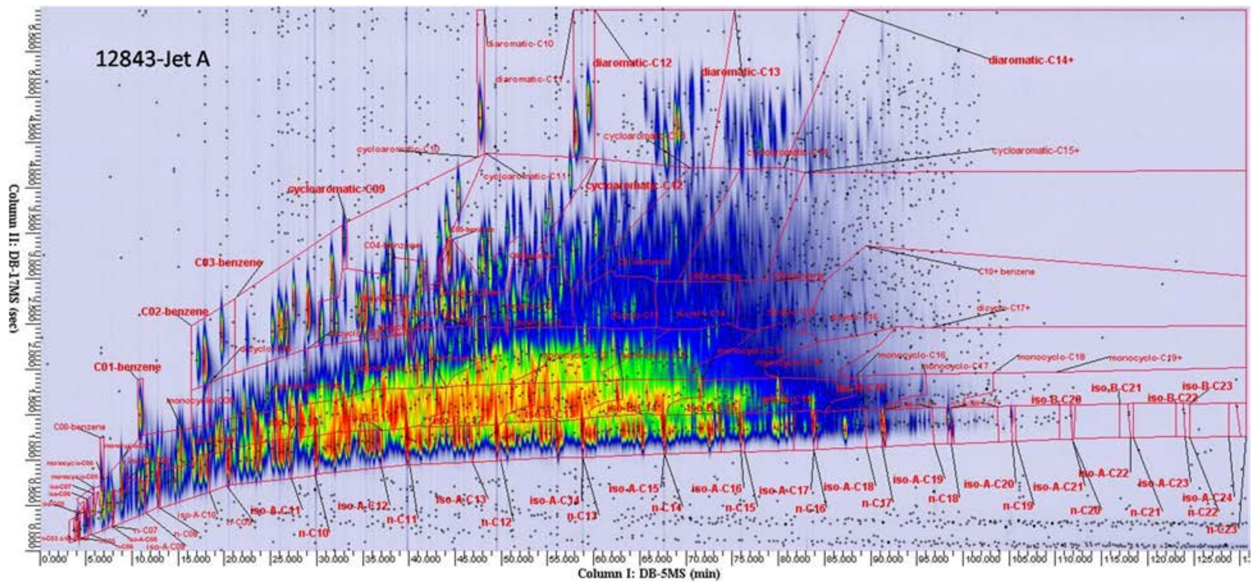


Figure M - 9 GCxGC Summary POSF-12843 Neat Fuel

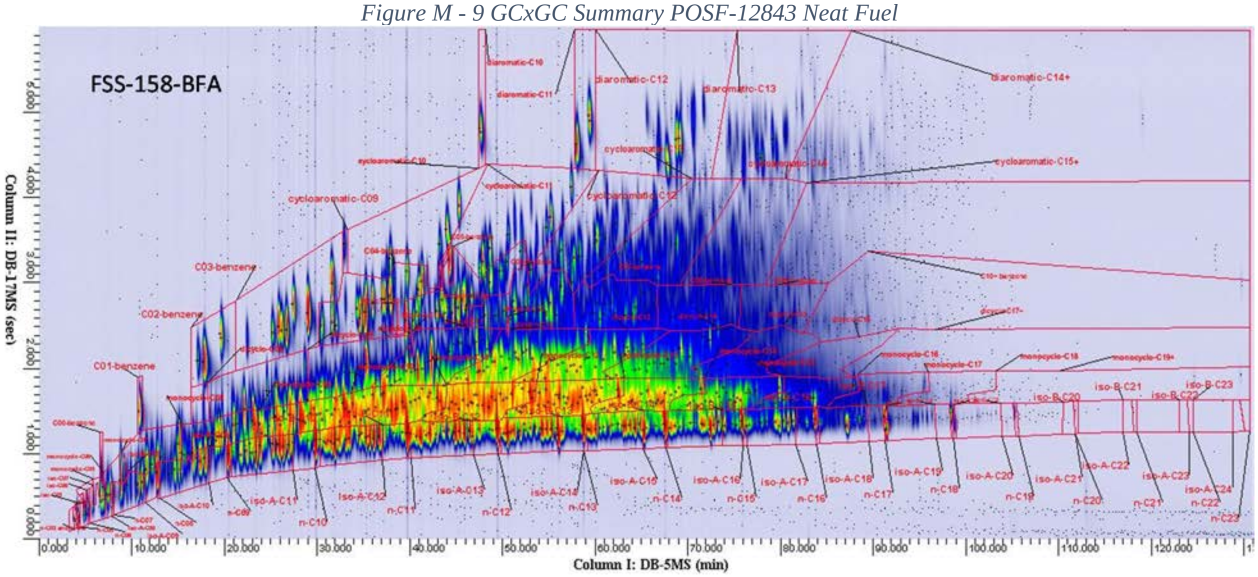


Figure M - 10 GCxGC Summary POSF-12843 Run 158 BFA Outlet

Table M - 1 GCxGC Tabulated Data POSF-12843 Jet A Neat and Run 158 BFA Outlet

GCxGC Summary				
Hydrogen content (weight %)	**13.9**		**13.9**	
Average Molecular Wt (g/mole)	**163**		**163**	
	POSF-12843- Jet A		**FSS158-BFA**	
	Weight %	**Volume %**	**Weight %**	**Volume %**
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	<0.01	<0.01
toluene (C07)	0.12	0.11	0.11	0.10
C2-benzene (C08)	0.56	0.52	0.55	0.51
C3-benzene (C09)	1.90	1.77	1.88	1.74
C4-benzene (C10)	2.45	2.29	2.45	2.28
C5-benzene (C11)	1.86	1.72	1.86	1.73
C6-benzene (C12)	1.62	1.51	1.57	1.46
C7-benzene (C13)	1.00	0.93	0.96	0.90
C8-benzene (C14)	0.83	0.77	0.80	0.75
C9-benzene (C15)	0.59	0.55	0.58	0.54
C10+-benzene (C16+)	0.40	0.37	0.37	0.35
Total Alkylbenzenes	**11.35**	10.56	**11.15**	10.37
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.10	0.08
diaromatic-C11	0.42	0.33	0.41	0.32
diaromatic-C12	0.73	0.58	0.71	0.57
diaromatic-C13	0.51	0.42	0.50	0.40
diaromatic-C14+	0.31	0.26	0.27	0.23
Total Alkylnaphthalenes	**2.08**	1.67	**1.99**	1.60
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.04	0.04	0.04	0.04
cycloaromatic-C10	0.37	0.30	0.35	0.29
cycloaromatic-C11	0.87	0.75	0.88	0.75
cycloaromatic-C12	1.16	1.01	1.21	1.05
cycloaromatic-C13	1.47	1.29	1.43	1.25
cycloaromatic-C14	0.83	0.73	0.83	0.73
cycloaromatics-C15+	0.41	0.36	0.44	0.39
Total Cycloaromatics	**5.16**	4.47	**5.18**	4.48
Total Aromatics	**18.59**	**16.70**	**18.33**	**16.45**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.22	0.27	0.22	0.26
C08-isoparaffins	0.44	0.50	0.43	0.49
C09-isoparaffins	0.84	0.94	0.82	0.92
C10-isoparaffins	3.27	3.60	3.31	3.65
C11-isoparaffins	4.25	4.59	4.35	4.69
C12-isoparaffins	3.56	3.85	3.66	3.96
C13-isoparaffins	3.40	3.59	3.50	3.70
C14-isoparaffins	3.18	3.34	3.10	3.26
C15-isoparaffins	2.29	2.39	2.34	2.44
C16-isoparaffins	1.06	1.10	1.07	1.11
C17-isoparaffins	0.56	0.58	0.51	0.52
C18-isoparaffins	0.15	0.15	0.15	0.16
C19-isoparaffins	0.08	0.08	0.08	0.08
C20-isoparaffins	0.03	0.03	0.03	0.03
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01
Total iso-Paraffins	**23.31**	25.01	**23.57**	25.27

n-Paraffins				
n-C07 & lower	0.17	0.20	0.17	0.20
n-C08	0.43	0.49	0.42	0.48
n-C09	1.01	1.13	1.00	1.12
n-C10	2.54	2.79	2.54	2.79
n-C11	3.01	3.26	2.99	3.24
n-C12	2.52	2.70	2.52	2.69
n-C13	2.00	2.12	2.01	2.13
n-C14	1.54	1.62	1.51	1.58
n-C15	0.89	0.93	0.89	0.93
n-C16	0.43	0.44	0.42	0.44
n-C17	0.20	0.20	0.18	0.19
n-C18	0.04	0.04	0.04	0.04
n-C19	<0.01	<0.01	<0.01	<0.01
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**14.80**	15.93	**14.71**	15.82
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.42	0.43	0.42	0.43
C08-monocyclocycloparaffins	0.63	0.64	0.62	0.63
C09-monocyclocycloparaffins	1.82	1.84	1.81	1.82
C10-monocyclocycloparaffins	4.60	4.50	4.59	4.49
C11-monocyclocycloparaffins	6.32	6.36	6.28	6.31
C12-monocyclocycloparaffins	5.57	5.57	5.70	5.69
C13-monocyclocycloparaffins	5.07	5.02	5.15	5.09
C14-monocyclocycloparaffins	3.15	3.12	3.25	3.22
C15-monocyclocycloparaffins	2.10	2.07	1.99	1.96
C16-monocyclocycloparaffins	0.86	0.85	1.07	1.05
C17-monocyclocycloparaffins	0.33	0.32	0.40	0.39
C18-monocyclocycloparaffins	0.05	0.05	0.06	0.05
C19+-monocyclocycloparaffins	<0.01	<0.01	0.01	0.01
Total Monocycloparaffins	**30.93**	30.78	**31.34**	31.17
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.45	0.42	0.54	0.50
C10-dicycloparaffins	1.01	0.90	1.00	0.89
C11-dicycloparaffins	2.32	2.17	2.11	1.98
C12-dicycloparaffins	2.69	2.54	2.61	2.46
C13-dicycloparaffins	3.00	2.83	3.08	2.90
C14-dicycloparaffins	1.94	1.83	1.93	1.82
C15-dicycloparaffins	0.60	0.56	0.57	0.54
C16-dicycloparaffins	0.21	0.20	0.08	0.07
C17+-dicycloparaffins	0.04	0.03	0.02	0.02
Total Dicycloparaffins	**12.27**	11.51	**11.96**	11.21
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.09	0.07	0.09	0.08
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.09**	0.08	**0.09**	0.08
Total Cycloparaffins	**43.29**	42.36	**43.40**	42.46
Average Molecular Formula - C	11.7		11.7	
Average Molecular Formula - H	22.4		22.4	

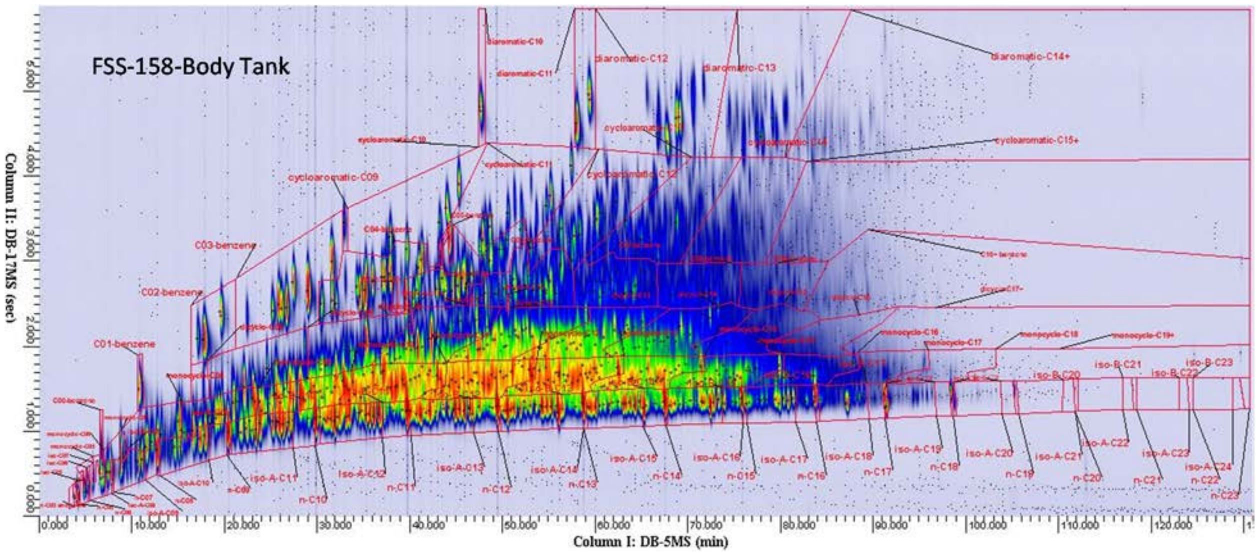


Figure M - 11 GCxGC Summary Fuel From Body Tank

Table M - 2 GCxGC Tabulated Data - Fuel From Body Tank at the End Of Run

GCxGC Summary				
Hydrogen content (weight %)	13.9		13.9	
Average Molecular Wt (g/mole)	163		163	
	POSF-12843- Jet A		FSS158-Body Tank	
	Weight %	Volume %	Weight %	Volume %
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	<0.01	<0.01
toluene (C07)	0.12	0.11	0.11	0.10
C2-benzene (C08)	0.56	0.52	0.55	0.51
C3-benzene (C09)	1.90	1.77	1.88	1.74
C4-benzene (C10)	2.45	2.29	2.44	2.27
C5-benzene (C11)	1.86	1.72	1.87	1.73
C6-benzene (C12)	1.62	1.51	1.64	1.52
C7-benzene (C13)	1.00	0.93	0.97	0.90
C8-benzene (C14)	0.83	0.77	0.75	0.70
C9-benzene (C15)	0.59	0.55	0.56	0.52
C10+-benzene (C16+)	0.40	0.37	0.37	0.34
Total Alkylbenzenes	**11.35**	10.56	**11.13**	10.35
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.10	0.08
diaromatic-C11	0.42	0.33	0.41	0.32
diaromatic-C12	0.73	0.58	0.71	0.57
diaromatic-C13	0.51	0.42	0.50	0.40
diaromatic-C14+	0.31	0.26	0.30	0.24
Total Alkylnaphthalenes	**2.08**	1.67	**2.02**	1.62
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.04	0.04	0.04	0.04
cycloaromatic-C10	0.37	0.30	0.36	0.30
cycloaromatic-C11	0.87	0.75	0.86	0.74
cycloaromatic-C12	1.16	1.01	1.18	1.02
cycloaromatic-C13	1.47	1.29	1.43	1.25
cycloaromatic-C14	0.83	0.73	0.87	0.76
cycloaromatics-C15+	0.41	0.36	0.40	0.35
Total Cycloaromatics	**5.16**	4.47	**5.14**	4.45
Total Aromatics	**18.59**	**16.70**	**18.29**	**16.42**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.22	0.27	0.21	0.26
C08-isoparaffins	0.44	0.50	0.43	0.49
C09-isoparaffins	0.84	0.94	0.82	0.92
C10-isoparaffins	3.27	3.60	3.34	3.69
C11-isoparaffins	4.25	4.59	4.39	4.73
C12-isoparaffins	3.56	3.85	3.56	3.85
C13-isoparaffins	3.40	3.59	3.23	3.42
C14-isoparaffins	3.18	3.34	3.34	3.50
C15-isoparaffins	2.29	2.39	2.34	2.44
C16-isoparaffins	1.06	1.10	1.05	1.09
C17-isoparaffins	0.56	0.58	0.52	0.54
C18-isoparaffins	0.15	0.15	0.13	0.14
C19-isoparaffins	0.08	0.08	0.08	0.08
C20-isoparaffins	0.03	0.03	0.03	0.03
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01
Total iso-Paraffins	**23.31**	25.01	**23.49**	25.19

n-Paraffins				
n-C07 & lower	0.17	0.20	0.17	0.20
n-C08	0.43	0.49	0.42	0.48
n-C09	1.01	1.13	1.00	1.12
n-C10	2.54	2.79	2.53	2.78
n-C11	3.01	3.26	3.01	3.25
n-C12	2.52	2.70	2.67	2.84
n-C13	2.00	2.12	2.01	2.13
n-C14	1.54	1.62	1.51	1.59
n-C15	0.89	0.93	0.89	0.93
n-C16	0.43	0.44	0.42	0.44
n-C17	0.20	0.20	0.18	0.19
n-C18	0.04	0.04	0.03	0.04
n-C19	<0.01	<0.01	<0.01	<0.01
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**14.80**	15.93	**14.87**	15.99
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.42	0.43	0.42	0.44
C08-monocyclocycloparaffins	0.63	0.64	0.61	0.62
C09-monocyclocycloparaffins	1.82	1.84	1.81	1.83
C10-monocyclocycloparaffins	4.60	4.50	4.33	4.24
C11-monocyclocycloparaffins	6.32	6.36	6.59	6.62
C12-monocyclocycloparaffins	5.57	5.57	5.52	5.52
C13-monocyclocycloparaffins	5.07	5.02	5.09	5.03
C14-monocyclocycloparaffins	3.15	3.12	3.25	3.22
C15-monocyclocycloparaffins	2.10	2.07	2.02	2.00
C16-monocyclocycloparaffins	0.86	0.85	0.91	0.90
C17-monocyclocycloparaffins	0.33	0.32	0.39	0.39
C18-monocyclocycloparaffins	0.05	0.05	0.07	0.07
C19+-monocyclocycloparaffins	<0.01	<0.01	0.01	<0.01
Total Monocycloparaffins	**30.93**	30.78	**31.04**	30.87
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.45	0.42	0.53	0.49
C10-dicycloparaffins	1.01	0.90	1.01	0.90
C11-dicycloparaffins	2.32	2.17	2.13	2.00
C12-dicycloparaffins	2.69	2.54	2.74	2.58
C13-dicycloparaffins	3.00	2.83	2.96	2.79
C14-dicycloparaffins	1.94	1.83	1.99	1.88
C15-dicycloparaffins	0.60	0.56	0.61	0.58
C16-dicycloparaffins	0.21	0.20	0.20	0.19
C17+-dicycloparaffins	0.04	0.03	0.02	0.02
Total Dicycloparaffins	**12.27**	11.51	**12.22**	11.45
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.09	0.07	0.09	0.08
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.09**	0.08	**0.09**	0.08
Total Cycloparaffins	**43.29**	42.36	**43.35**	42.40
Average Molecular Formula - C	11.7		11.7	
Average Molecular Formula - H	22.4		22.4	

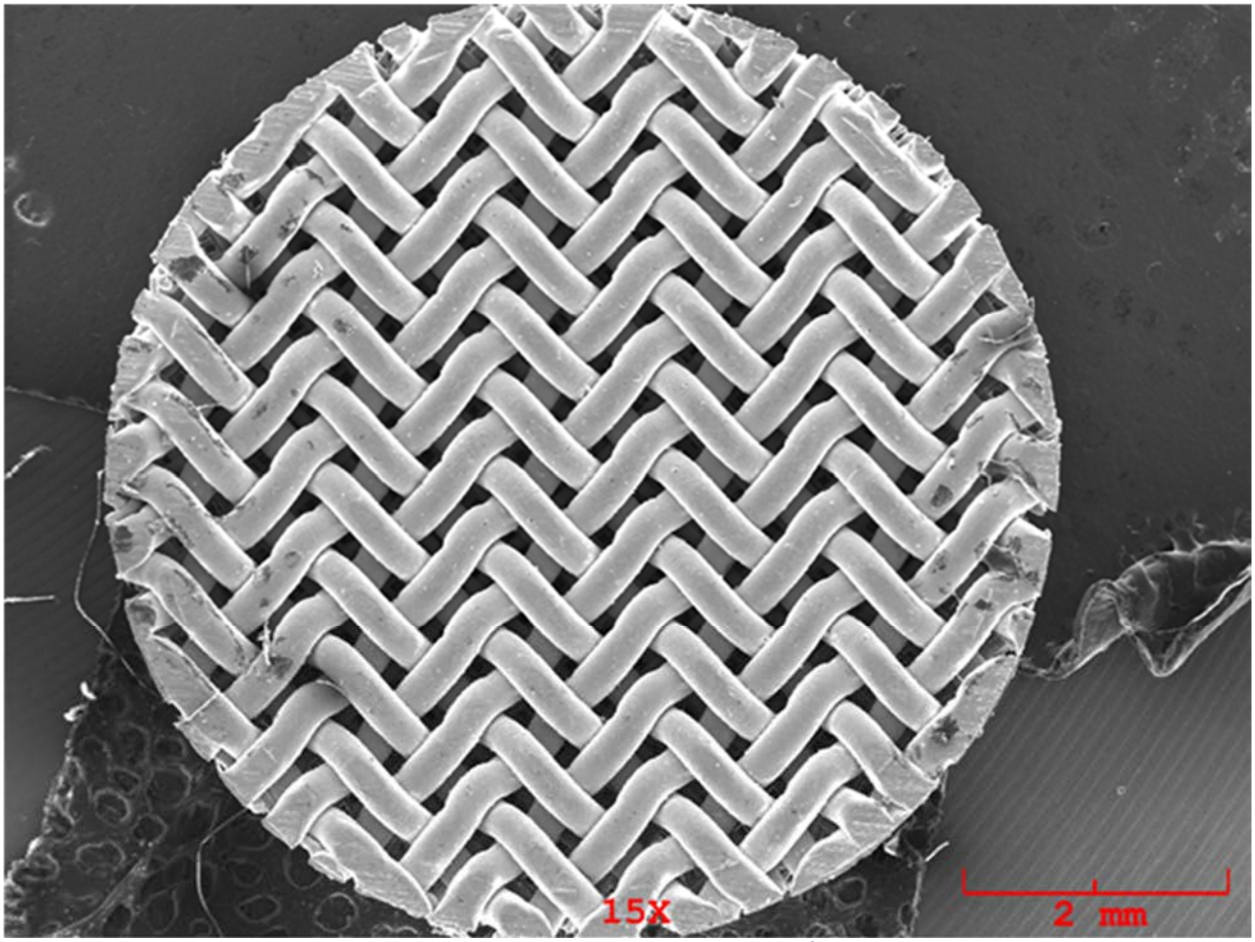
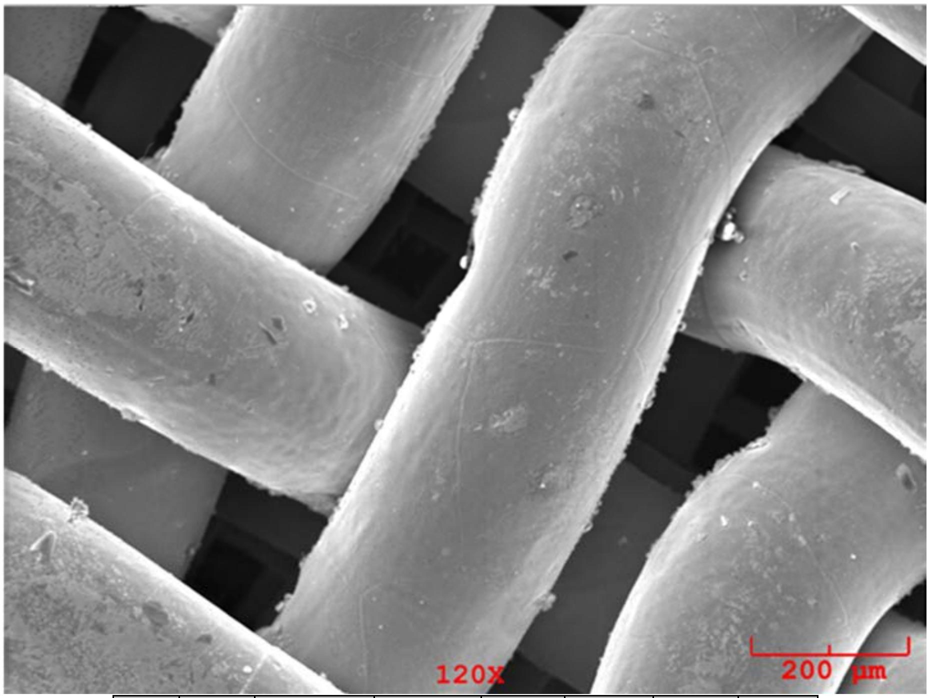


Figure M - 12 TMS Screen, Top, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	3.33	1.875	wt.%	0.455	0.621	
O	Ka	2.82	0.553	wt.%	0.144	0.195	
Al	Ka	2.84	0.397	wt.%	0.136	0.195	
Si	Ka	4.54	0.510	wt.%	0.118	0.165	
S	Ka	11.58	1.021	wt.%	0.108	0.138	
Cr	Ka	137.83	16.823	wt.%	0.312	0.189	
Mn	Ka	7.23	1.209	wt.%	0.196	0.267	
Fe	Ka	338.60	68.199	wt.%	0.768	0.306	
Ni	Ka	29.33	8.844	wt.%	0.416	0.394	
Cu	Ka	1.53	0.568	wt.%	0.286	0.414	
			100.000	wt.%			Total

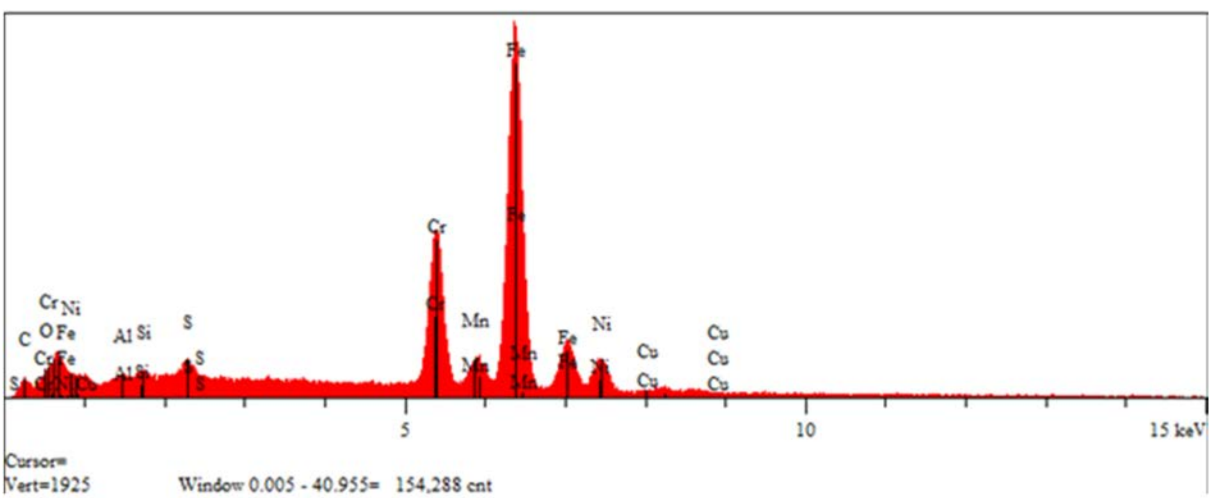


Figure M - 13 TMS Screen Top, 120X and EDX Elemental Analysis

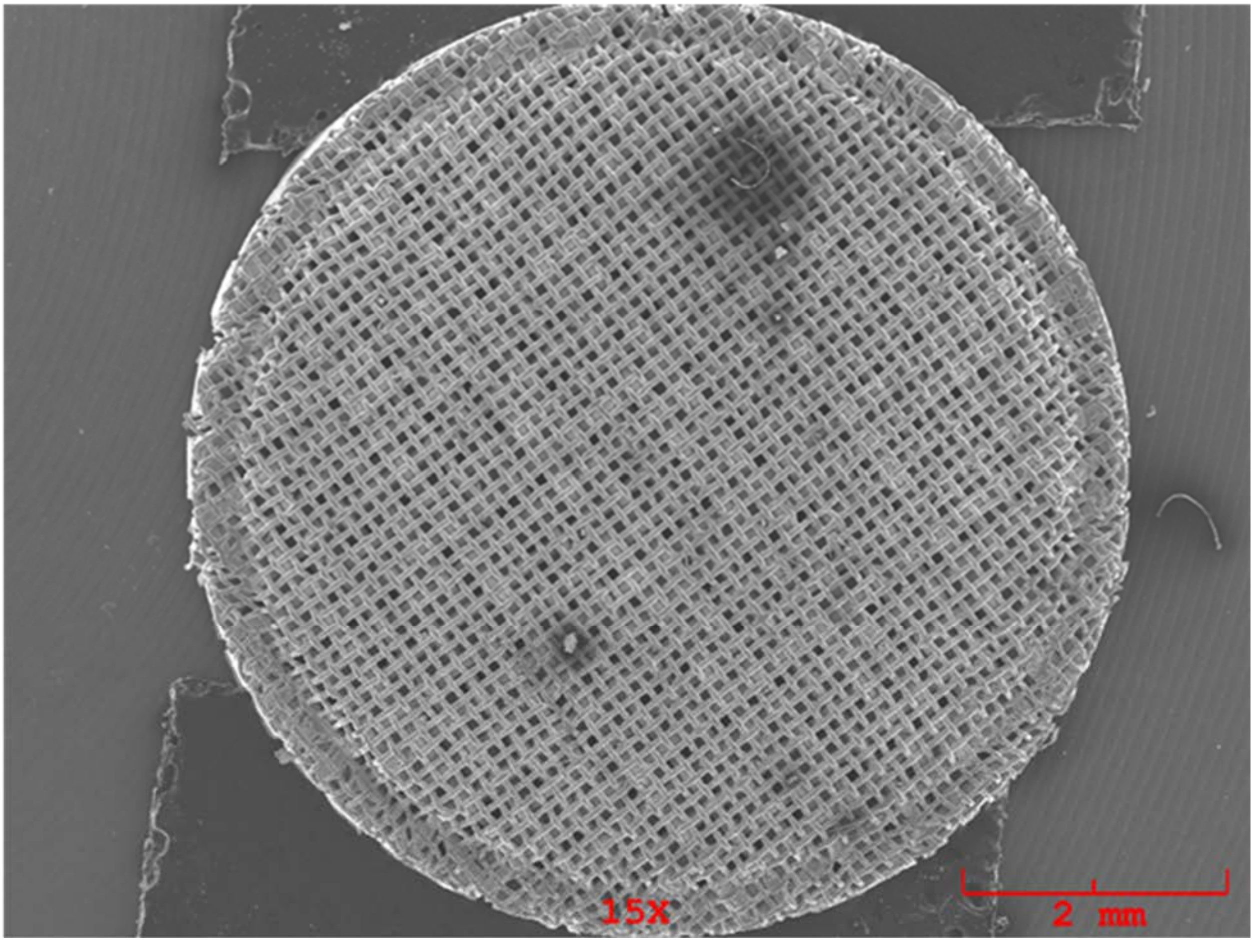
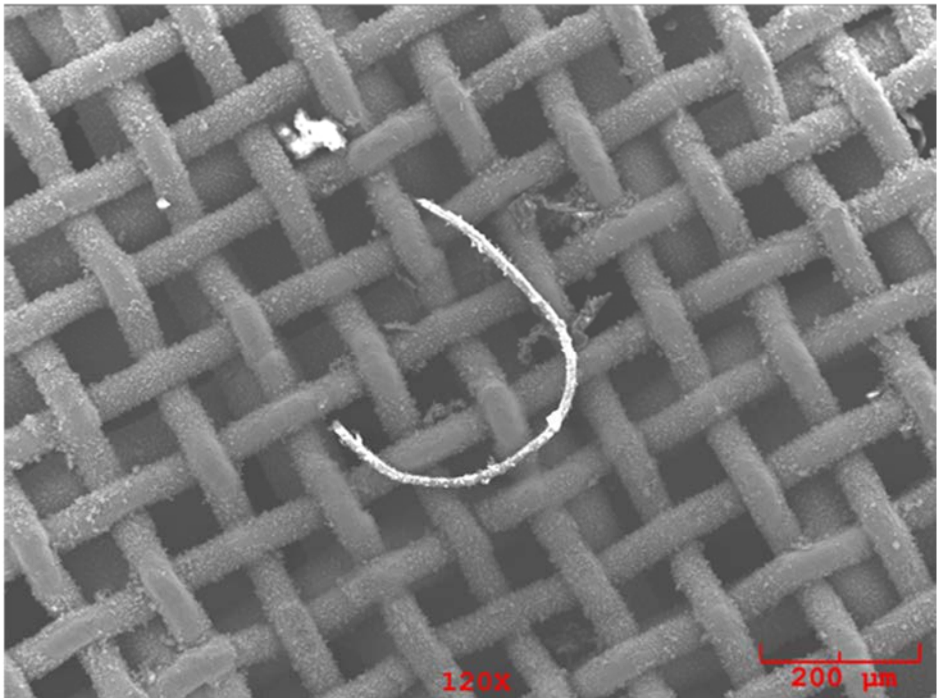


Figure M - 14 TMS Screen, Bottom, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	12.39	13.021	wt.%	1.051	1.142	
O	Ka	3.90	1.669	wt.%	0.316	0.408	
Al	Ka	2.57	0.538	wt.%	0.177	0.251	
Si	Ka	0.89	0.152	wt.%	0.144	0.215	
S	Ka	48.42	6.634	wt.%	0.225	0.182	
Cr	Ka	62.36	12.798	wt.%	0.361	0.242	
Mn	Ka	3.16	0.859	wt.%	0.239	0.335	
Fe	Ka	155.82	50.195	wt.%	0.843	0.386	
Ni	Ka	10.98	5.152	wt.%	0.436	0.467	
Zn	Ka	12.57	8.982	wt.%	0.656	0.637	
			100.000	wt.%			Total

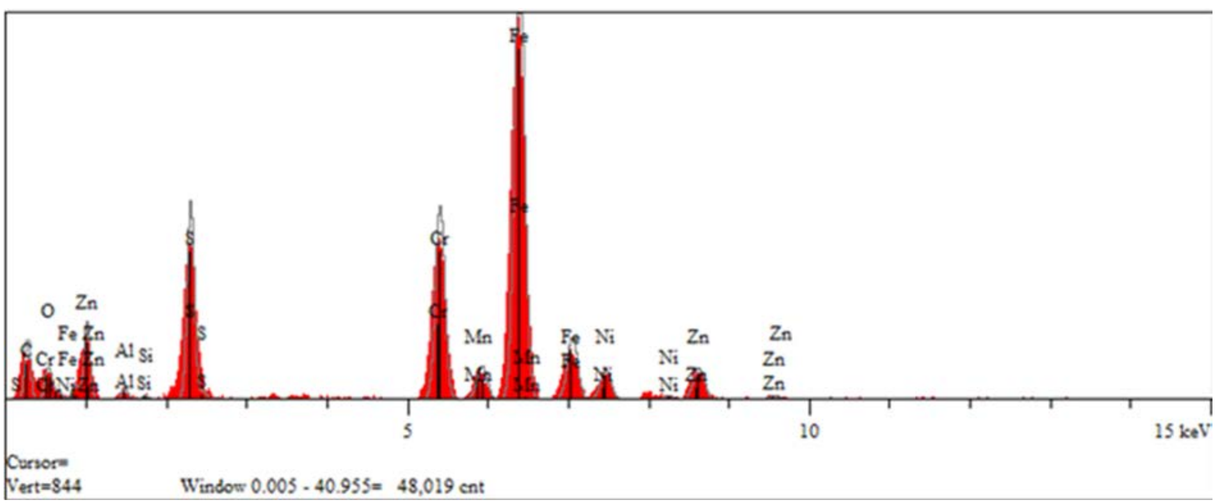


Figure M - 15 TMS Screen, Bottom, 120X and EDX Elemental Analysis

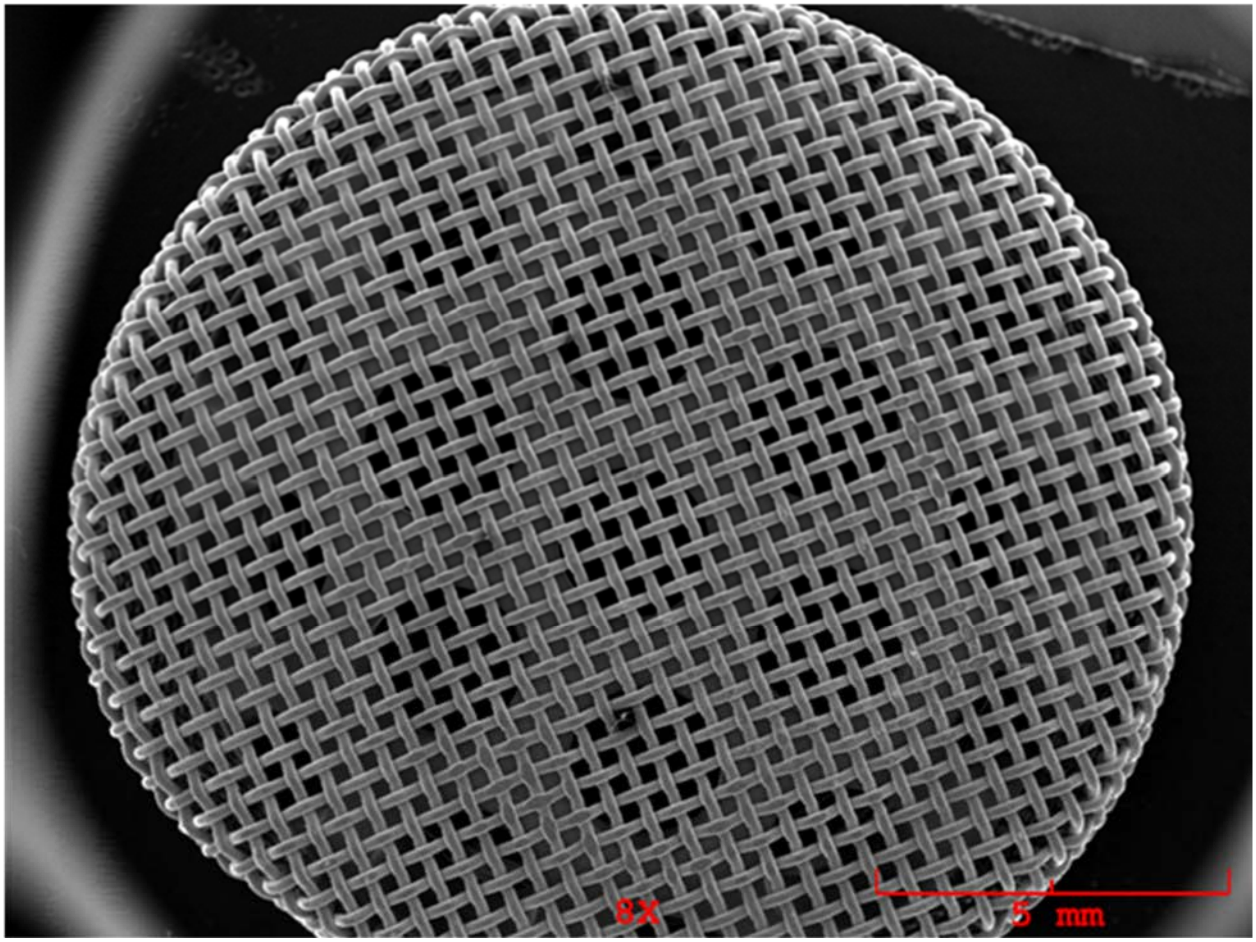
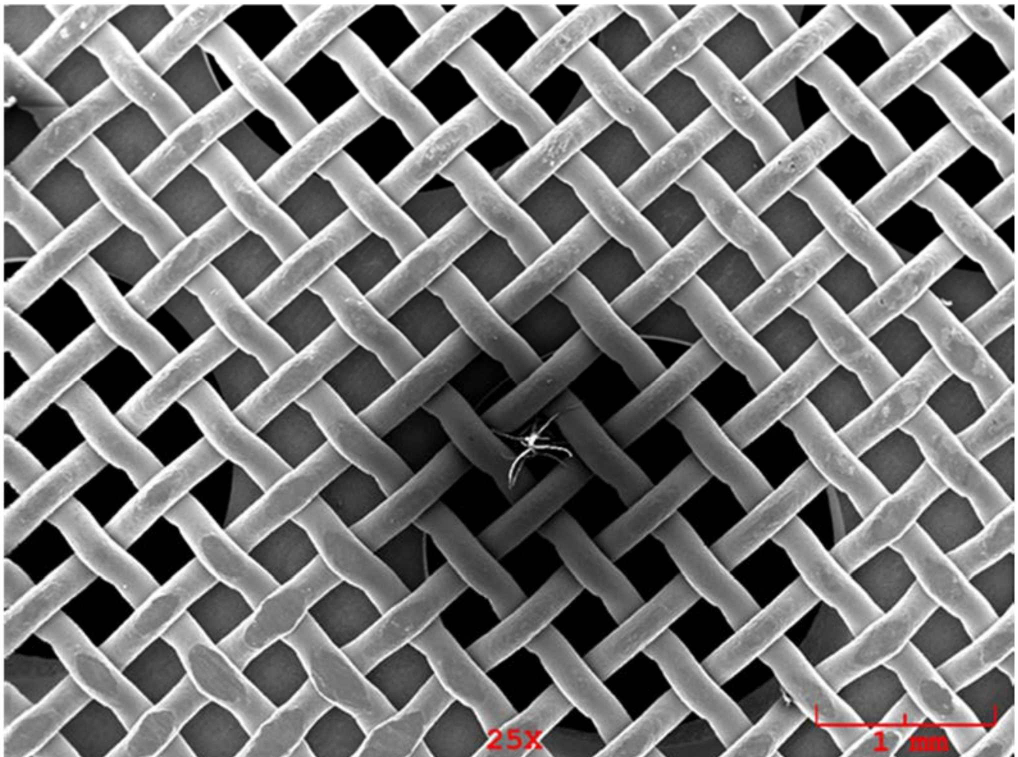


Figure M - 16 F303 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	1.60	1.227	wt.%	0.497	0.701	
Si	Ka	2.85	0.434	wt.%	0.135	0.191	
S	Ka	10.32	1.230	wt.%	0.130	0.161	
Cr	Ka	96.15	15.624	wt.%	0.349	0.218	
Mn	Ka	5.39	1.210	wt.%	0.227	0.309	
Fe	Ka	260.34	70.453	wt.%	0.904	0.355	
Ni	Ka	24.14	9.821	wt.%	0.489	0.432	
			100.000	wt.%			Total

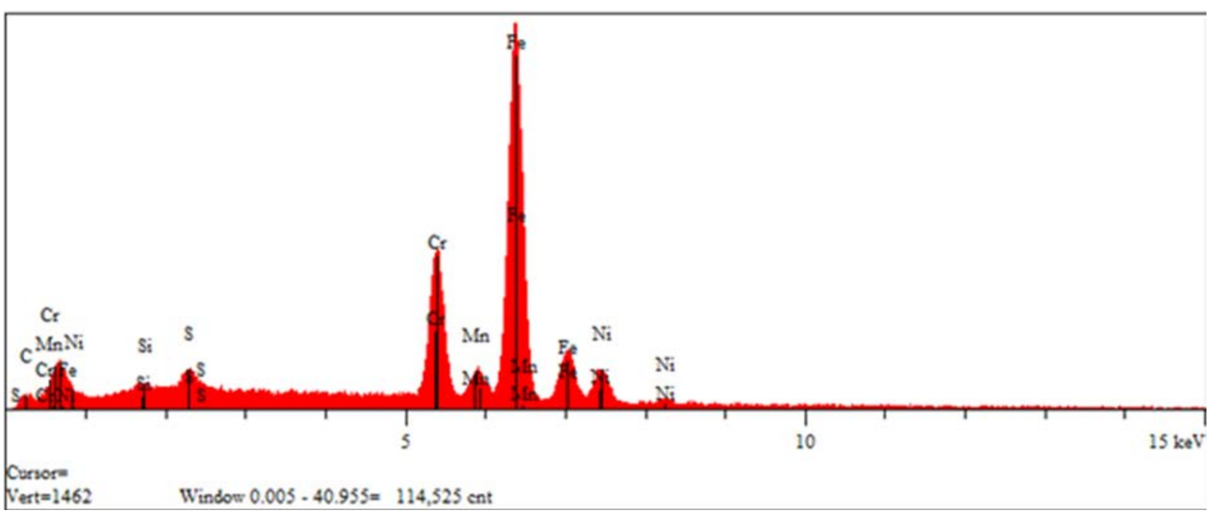


Figure M - 17 F303 Bottom 25X and EDX Elemental Analysis

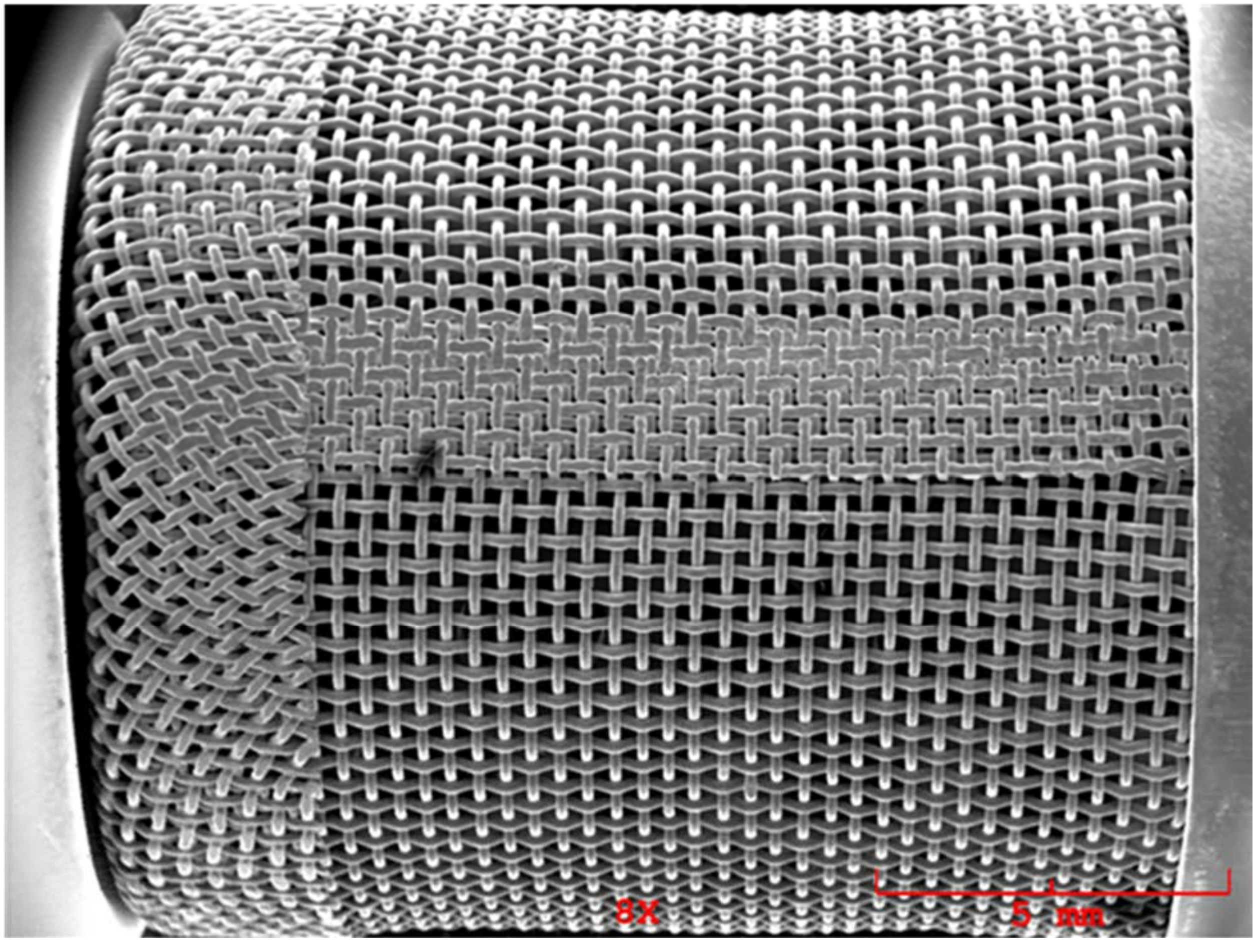
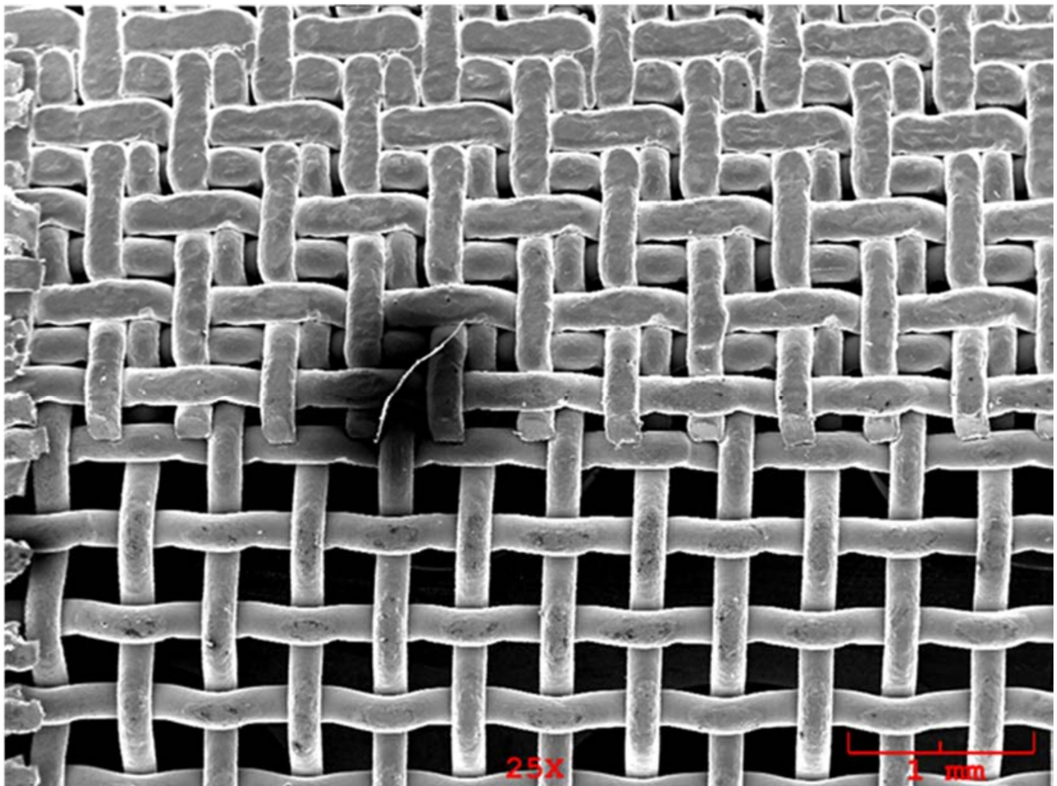


Figure M - 18 F303 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	3.80	2.086	wt.%	0.409	0.533	
Si	Ka	3.39	0.372	wt.%	0.112	0.160	
S	Ka	13.71	1.179	wt.%	0.110	0.137	
Cr	Ka	135.16	15.938	wt.%	0.299	0.183	
Mn	Ka	6.76	1.099	wt.%	0.192	0.263	
Fe	Ka	355.49	69.696	wt.%	0.767	0.311	
Ni	Ka	32.71	9.630	wt.%	0.426	0.400	
			100.000	wt.%			Total

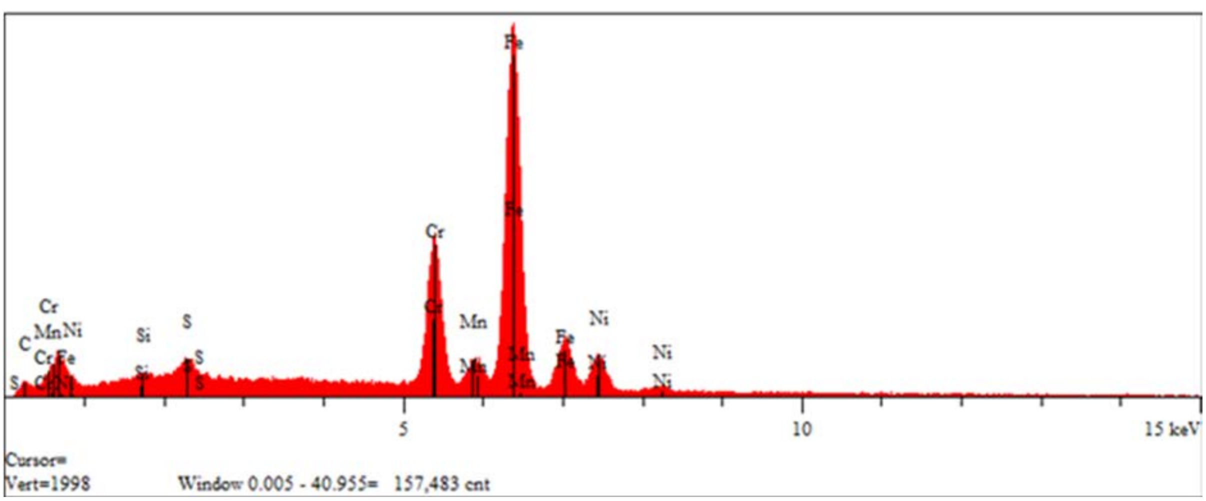


Figure M - 19 F303 Side 25X and EDX Elemental Analysis

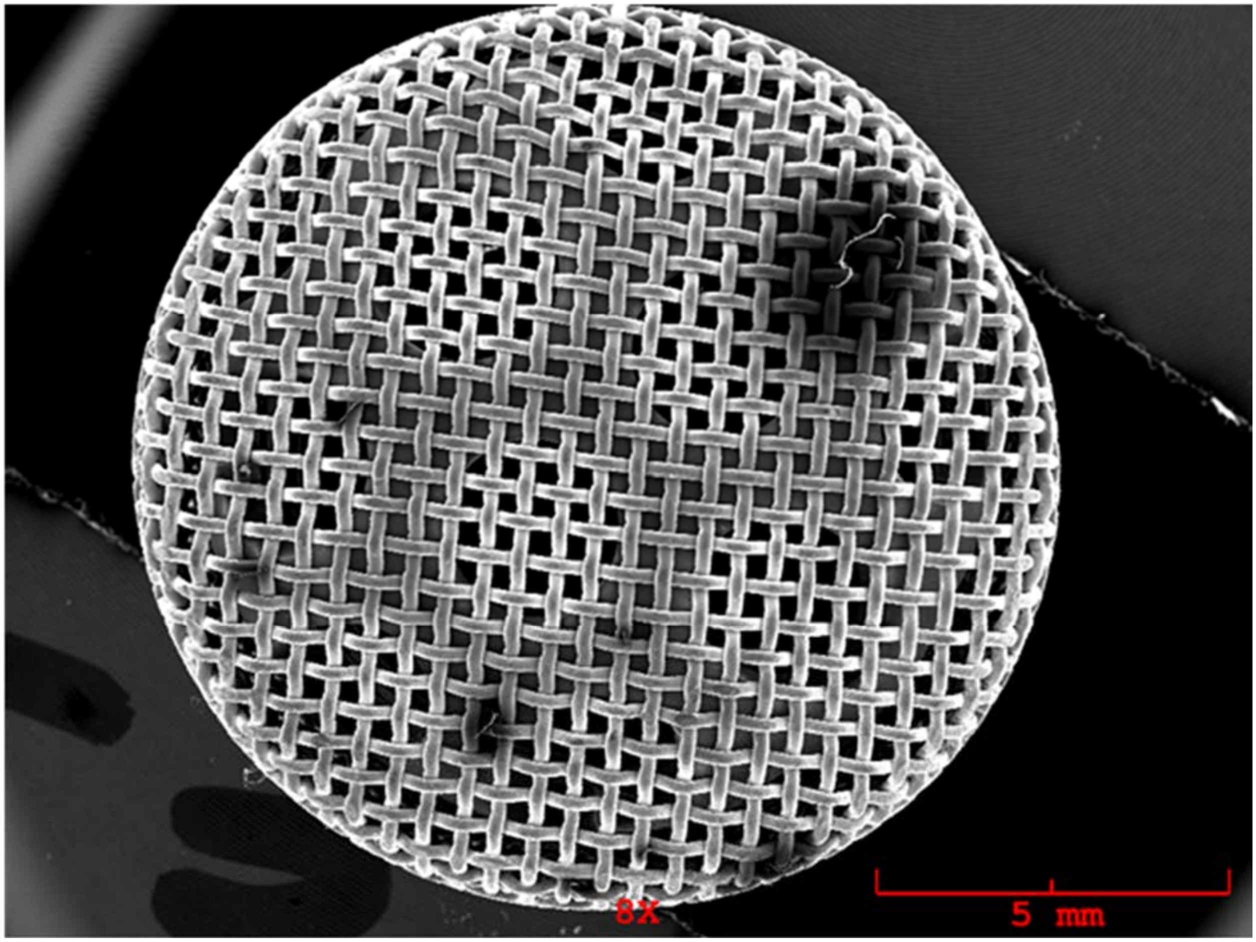
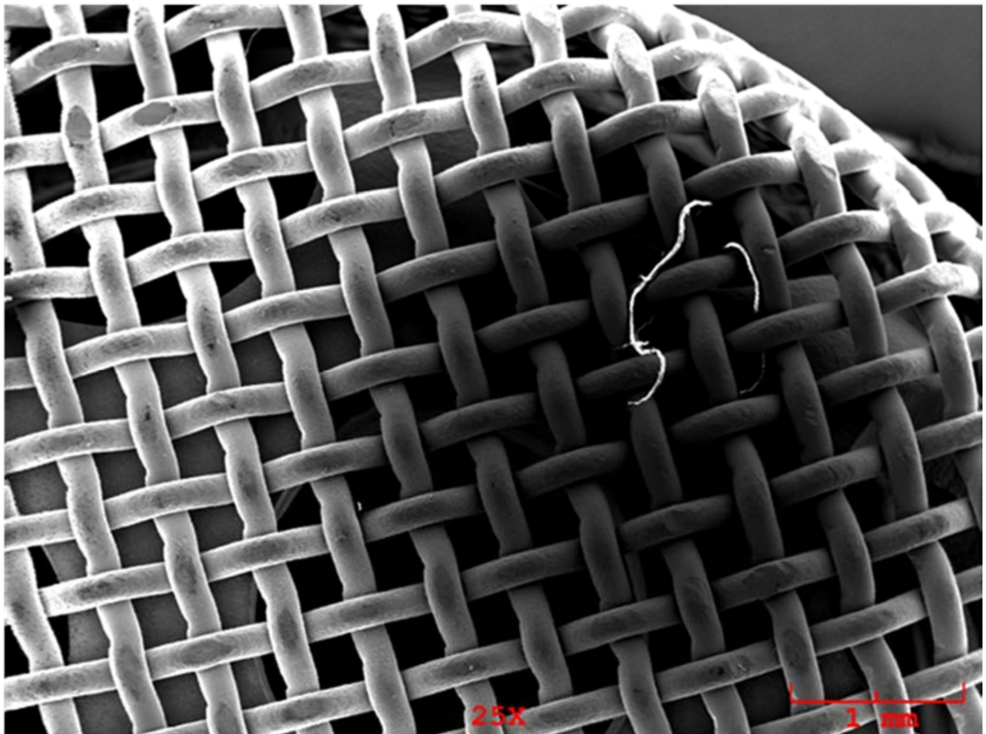


Figure M - 20 F304 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	9.08	5.912	wt.%	0.632	0.759	
Al	Ka	71.82	9.398	wt.%	0.253	0.186	
S	Ka	23.66	2.136	wt.%	0.126	0.139	
V	Ka	0.25	0.030	wt.%	0.115	0.174	
Cr	Ka	106.00	13.479	wt.%	0.290	0.189	
Mn	Ka	7.88	1.351	wt.%	0.197	0.263	
Fe	Ka	291.22	59.610	wt.%	0.727	0.308	
Ni	Ka	26.60	8.084	wt.%	0.401	0.384	
			100.000	wt.%			Total

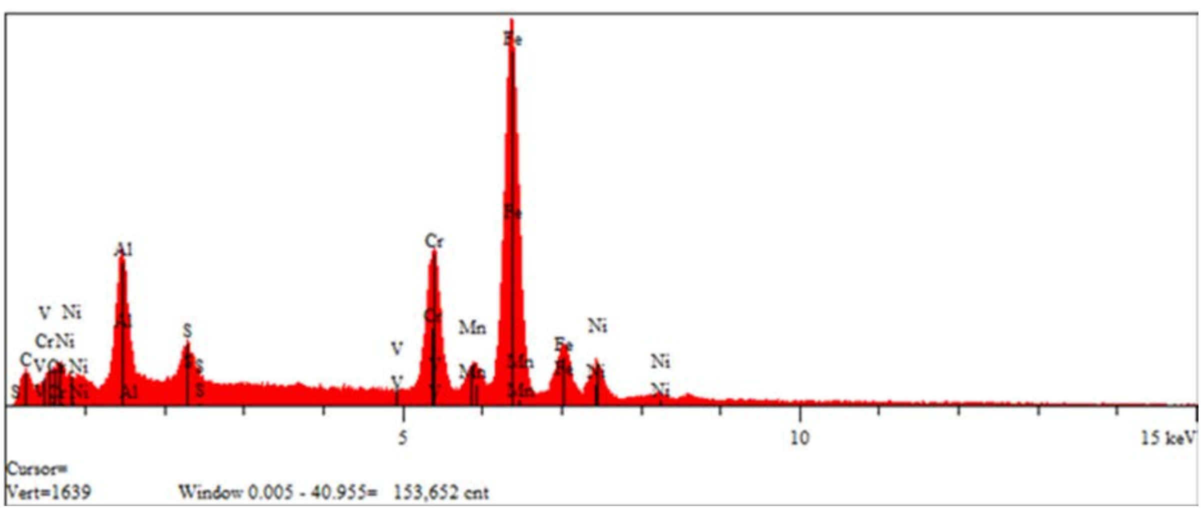


Figure M – 21 F304 Bottom, 25X and EDX Elemental Analysis

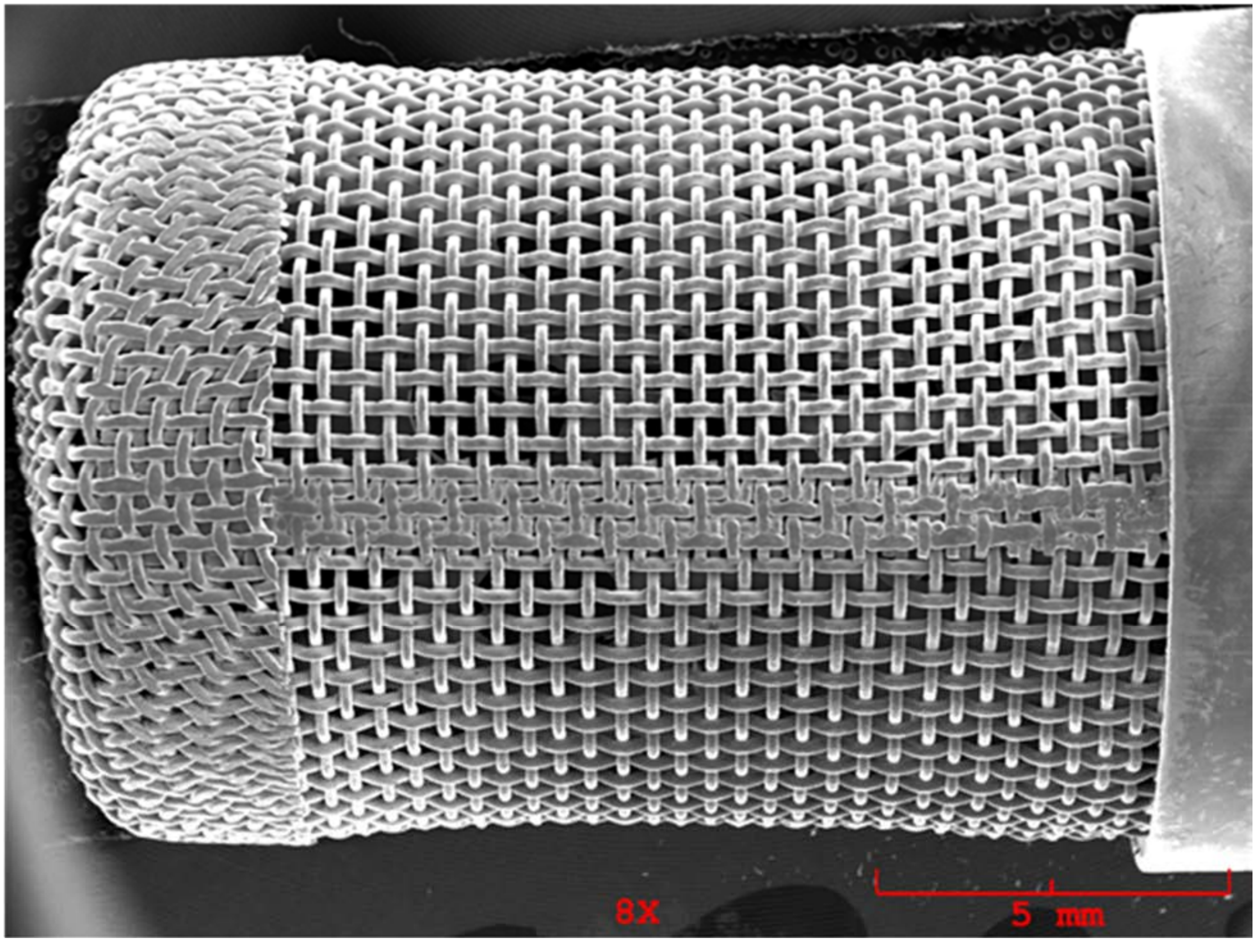
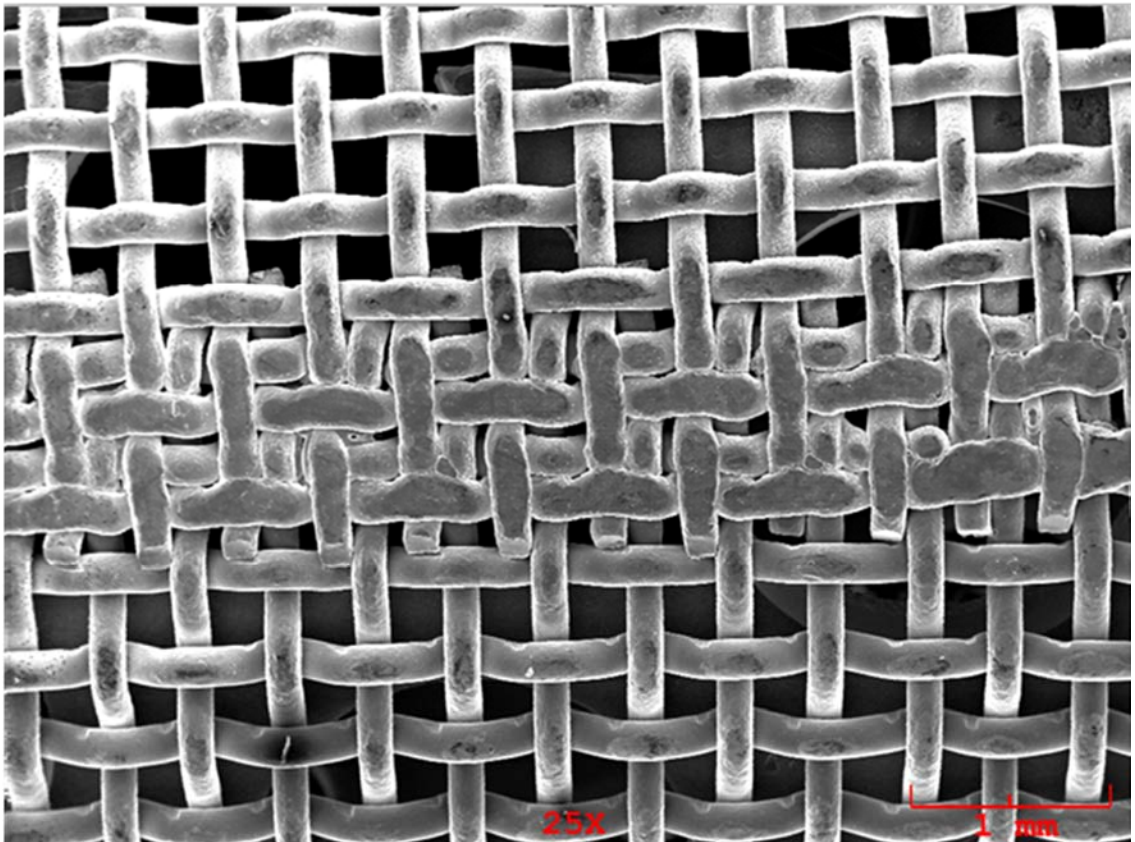


Figure M - 22 F304 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	6.29	4.138	wt.%	0.553	0.680	
S	Ka	22.29	2.240	wt.%	0.138	0.153	
Cr	Ka	105.96	14.753	wt.%	0.315	0.200	
Mn	Ka	6.98	1.340	wt.%	0.212	0.286	
Fe	Ka	295.06	68.171	wt.%	0.824	0.336	
Ni	Ka	26.98	9.357	wt.%	0.458	0.434	
			100.000	wt.%			Total

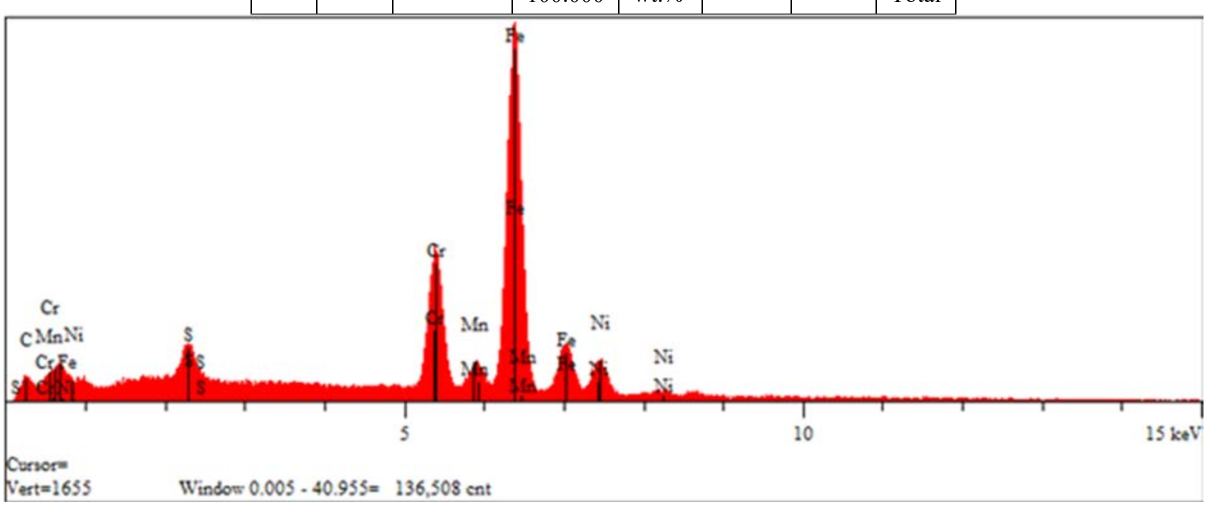


Figure M - 23 F304 Side, 25X and EDX Elemental Analysis

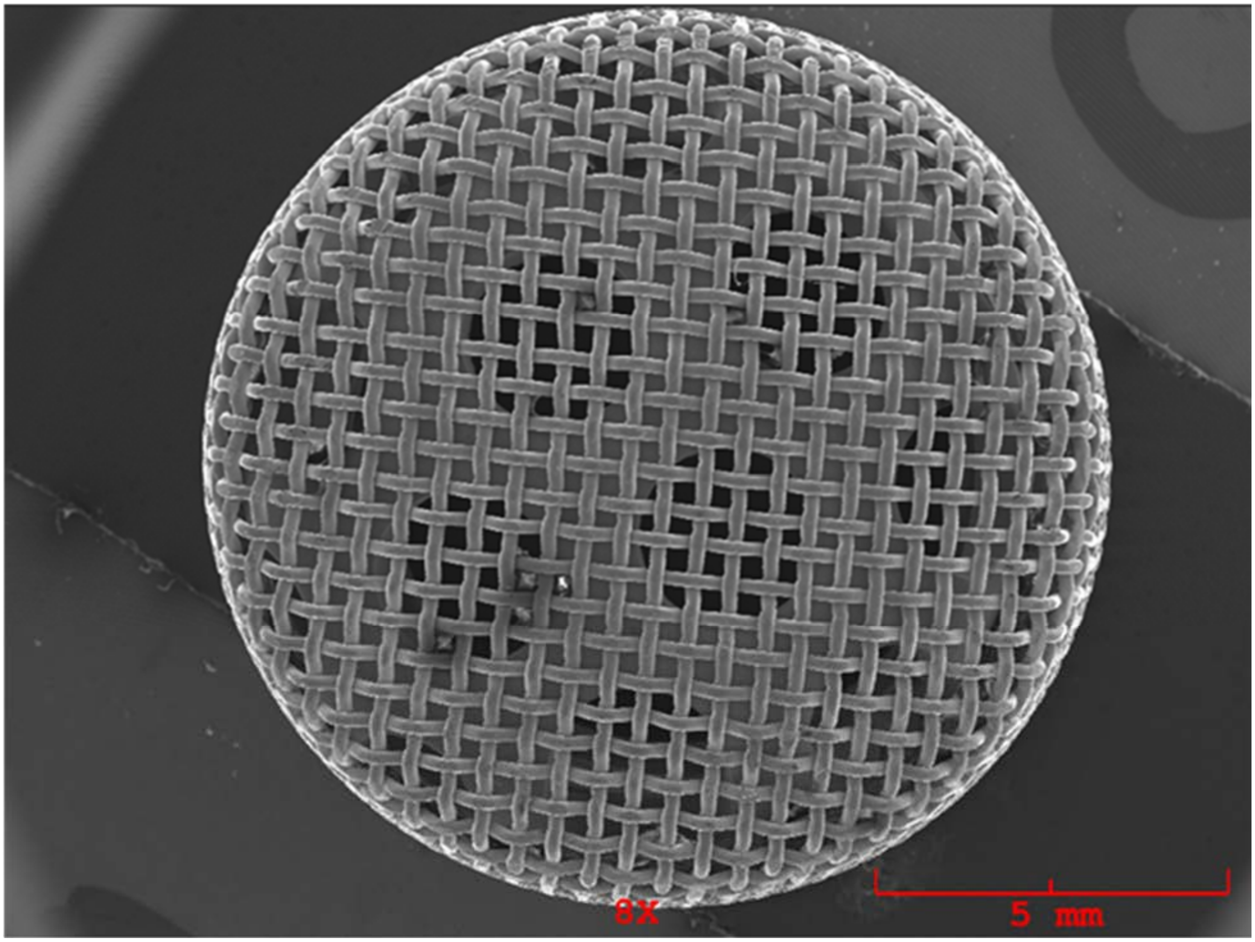
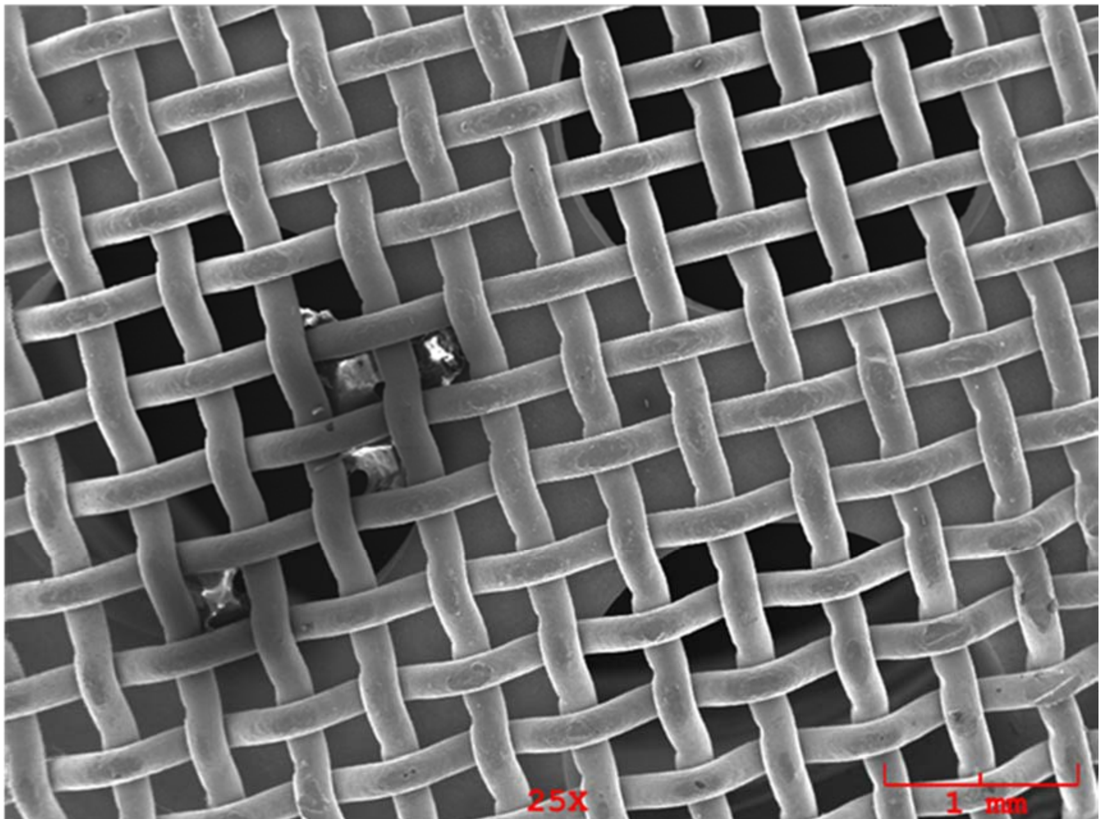


Figure M - 24 F702 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	1.88	1.310	wt.%	0.452	0.626	
Al	Ka	0.31	0.052	wt.%	0.140	0.213	
Si	Ka	4.09	0.557	wt.%	0.131	0.183	
S	Ka	13.98	1.495	wt.%	0.126	0.150	
Cr	Ka	107.96	15.835	wt.%	0.332	0.201	
Mn	Ka	6.77	1.368	wt.%	0.216	0.289	
Fe	Ka	286.99	69.811	wt.%	0.853	0.335	
Ni	Ka	26.20	9.571	wt.%	0.465	0.423	
			100.000	wt.%			Total

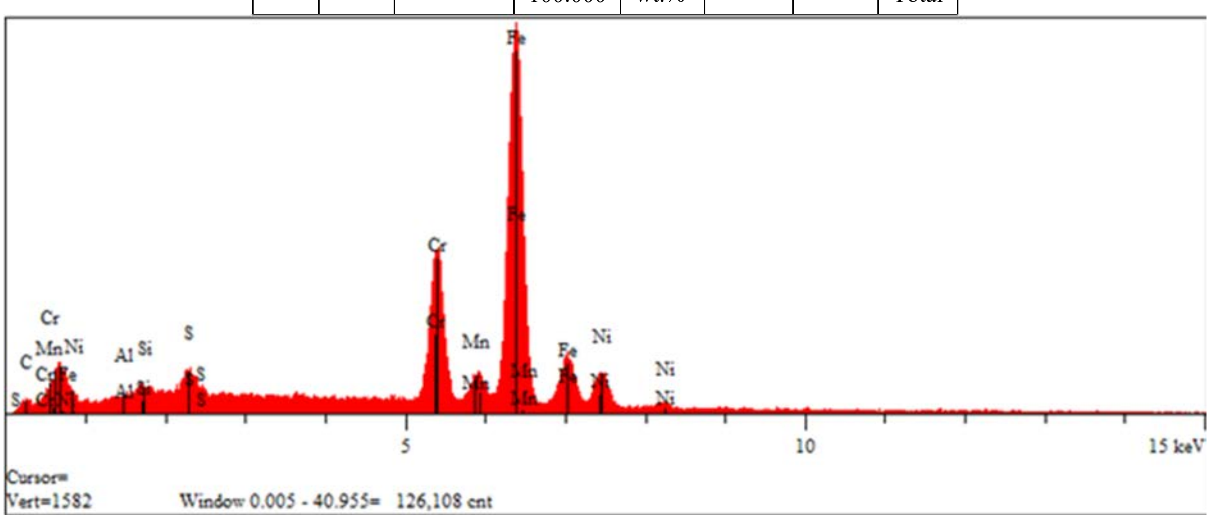


Figure M - 25 F702 Bottom, 25X and EDX Elemental Analysis

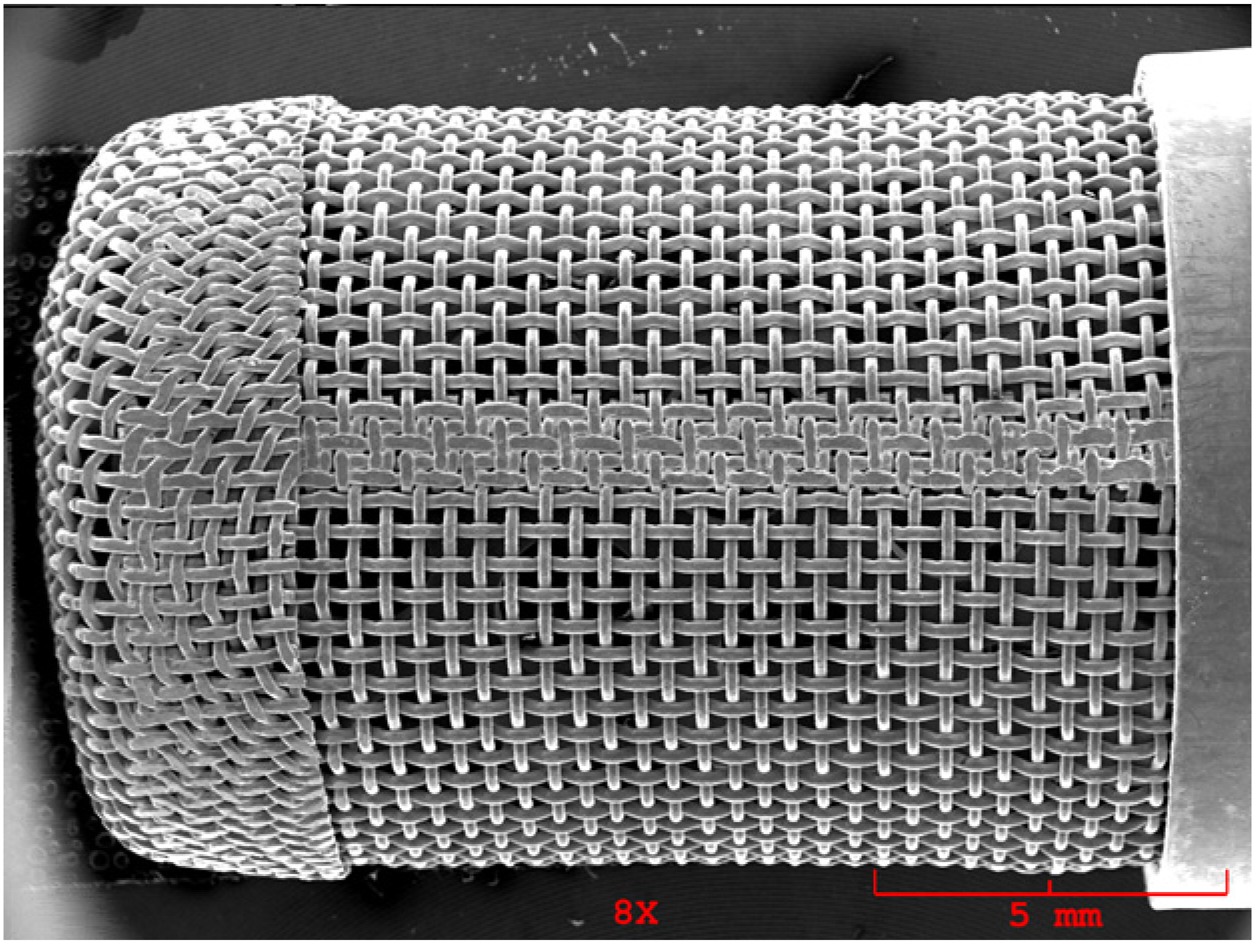
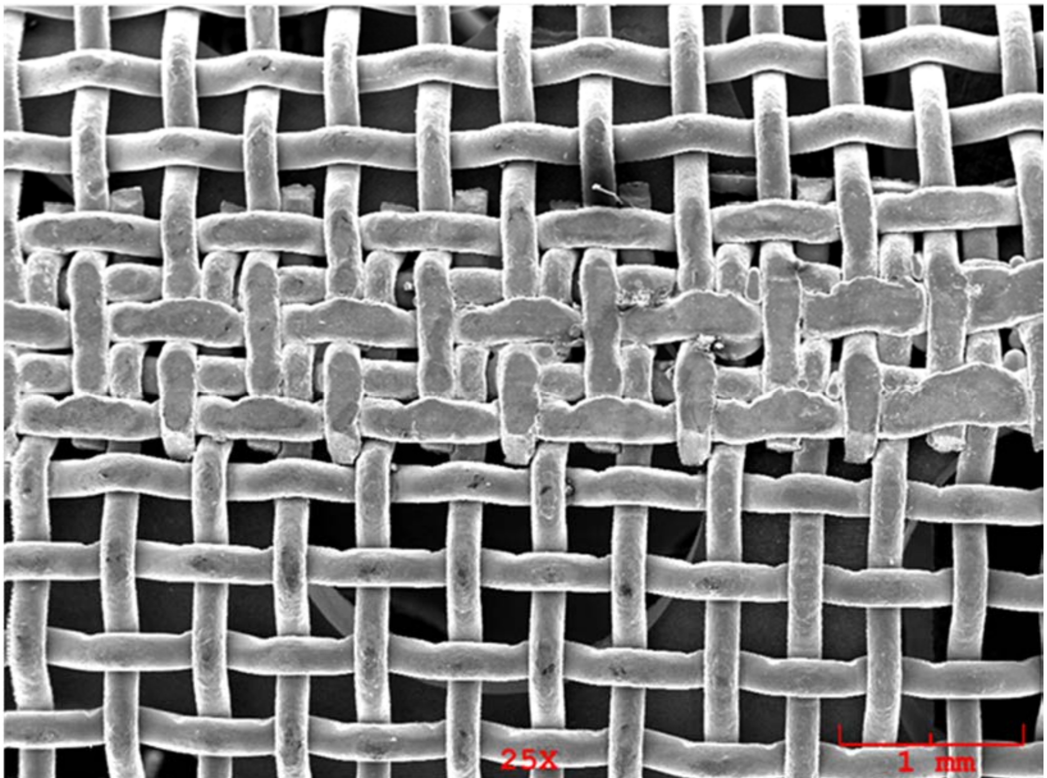


Figure M - 26 F702 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	2.77	1.645	wt.%	0.434	0.592	
Si	Ka	3.15	0.365	wt.%	0.117	0.167	
S	Ka	19.00	1.725	wt.%	0.124	0.146	
Cr	Ka	126.54	15.797	wt.%	0.307	0.190	
Mn	Ka	6.99	1.202	wt.%	0.199	0.270	
Fe	Ka	335.81	69.520	wt.%	0.785	0.307	
Ni	Ka	31.35	9.746	wt.%	0.436	0.403	
			100.000	wt.%			Total

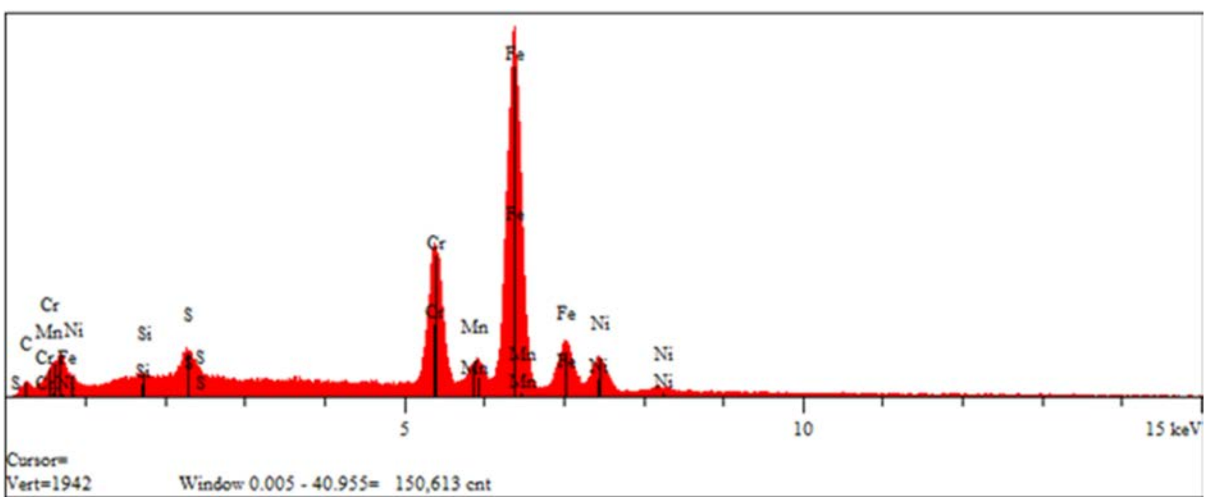


Figure M -27 F702 Side, 25X and EDX Elemental Analysis

APPENDIX N - RUN 159 DATA PACKAGE

Run Conditions: EDTST Mode, HT Conditions
Fuel ID: POSF-12843, Ft McCoy **with 2.54 mg/L SpecAid 8Q462 (+100)**
Airframe Heat Exchanger Bulk Fuel Output: 285 °F
HP Pump HX Out/FCOC Bulk Fuel In: 350 °F
Fuel-Cooled Oil Cooler Bulk Fuel Output: 375 °F
Burner Feed Arm Max Wetted Wall Temperature: 510 °F
Run Duration: 72 Hours

DATA SUMMARY

Run 159; Run Type: EDTST; Op Mode: HT; MSNs: N/A; EDTST Run Hours: 72 Fuel ID#: POSF12899; Run Tank: Drums; Run Type: EDTST; Op Mode: HT Fuel Type: F-24; Additive(s): GE Betz +100 AFHX Out: 285 °F; FCOC In: 325 °F; FCOC Out: 375 °F; BFA MWWT:

Component/Device	Serial No.	Pre-Test %	Post-Test %	Spread (Pre/Post Delta), %	Shift, PPH	Skew, PSID	Flow Range Shift, PPH	Flow Midpoint Shift, PPH	Overall Rating	Hysteresis Area Change (PPH-DP)
FDV	1248	2.1	6.5	4.4	-0.2	0.3	2.7	1.4	Minor	39
Servo2	013	2.4	4.0	1.6	-1.7	-0.6	-0.3	-0.2	Minor	80

Effective Carbon - µgrams

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	68.0	91.3	107.2	88.8	99.7					
BFA	66.5	90.6	127.8	227.6	263.5	330.2	416.3	355.0	302.2	274.2
Total FCOC Carbon, µgrams		455.1	µgrams	0.5	mgrams					
Total BFA Carbon, µgrams		2453.8	µgrams	2.5	mgrams					

SCREENS	Total Carbon, µg	Background Carbon, µg	Effective Carbon, µg	MWWT Start	MWWT End	Delta BFA MWWT	TE	BFA AWWT Start	BFA AWWT End	Delta BFA AWWT
TMS	18.4	0.3	18.1	510.25	514.48	4.24	MAX	493.59	496.59	3.00
F303	48.5	25.4	23.1	496.66	498.98	2.32	TE325	SV Inlet (TE702)	FDV Inlet (TE313)	BFA Inlet (TE316)
F304	53.7	12.9	40.8	500.30	502.94	2.64	TE324			
F305	0.0	0.0	0.0	510.25	514.48	4.24	TE323	368	352	350
F702	122.1	12.9	109.2	504.47	507.70	3.24	TE322			

Effective Carbon Deposition - µgrams/cm^2

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	18.6	25.0	29.4	24.3	27.3					
BFA	38.6	52.6	74.2	132.1	152.9	191.7	241.6	206.0	175.4	159.2

TMS Mass Change - grams

Component/Device	Tare, g	Mass, g	Mass Gain, g
TMS	0.08668	0.08666	-0.00002
F303	7.17480	7.17453	-0.00027
F304	3.03458	3.03452	-0.00006
F305	0.00000	0.00000	0.00000
F702	3.04414	3.04435	0.00021

Hysteresis Ratings:

- NONE: indicating that the pre-test and post-test hysteresis curves, for all intents and purposes, are nearly indistinguishable from one another. Minor differences may be seen between the pre-test and post-test curves but these are very small.
- Minor: There are small differences between per- and post-test curves. The spread for these curves is typically within 5% of one another. There may be some small changes in shift and skew for the valve. This degree of hysteresis would not be expected to alter the functional nature of the valve.
- Moderate: There are definite differences between pre-and post-test curves. There may be definite differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically between 5% and 15%. This degree of hysteresis might be expected to alter the functional nature of the valve.
- Severe: There are pronounce differences between pre-and post-test curves. There may be pronounced differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically in excess 15%. This degree of hysteresis would be considered out-of-spec for the valve.
- Non-Functional: There are major differences between pre-and post-test curves. There may be major differences in shift and skew as well. The hysteresis curve will exhibit flat segments (either vertically or horizontally). Shift and skew have majorly changed the performance envelope of the valve. This degree of hysteresis would cause the valve to be non-functional or unresponsive over small or large portions of the performance range of the valve.

Figure N - 1 Run 159 Data Summary

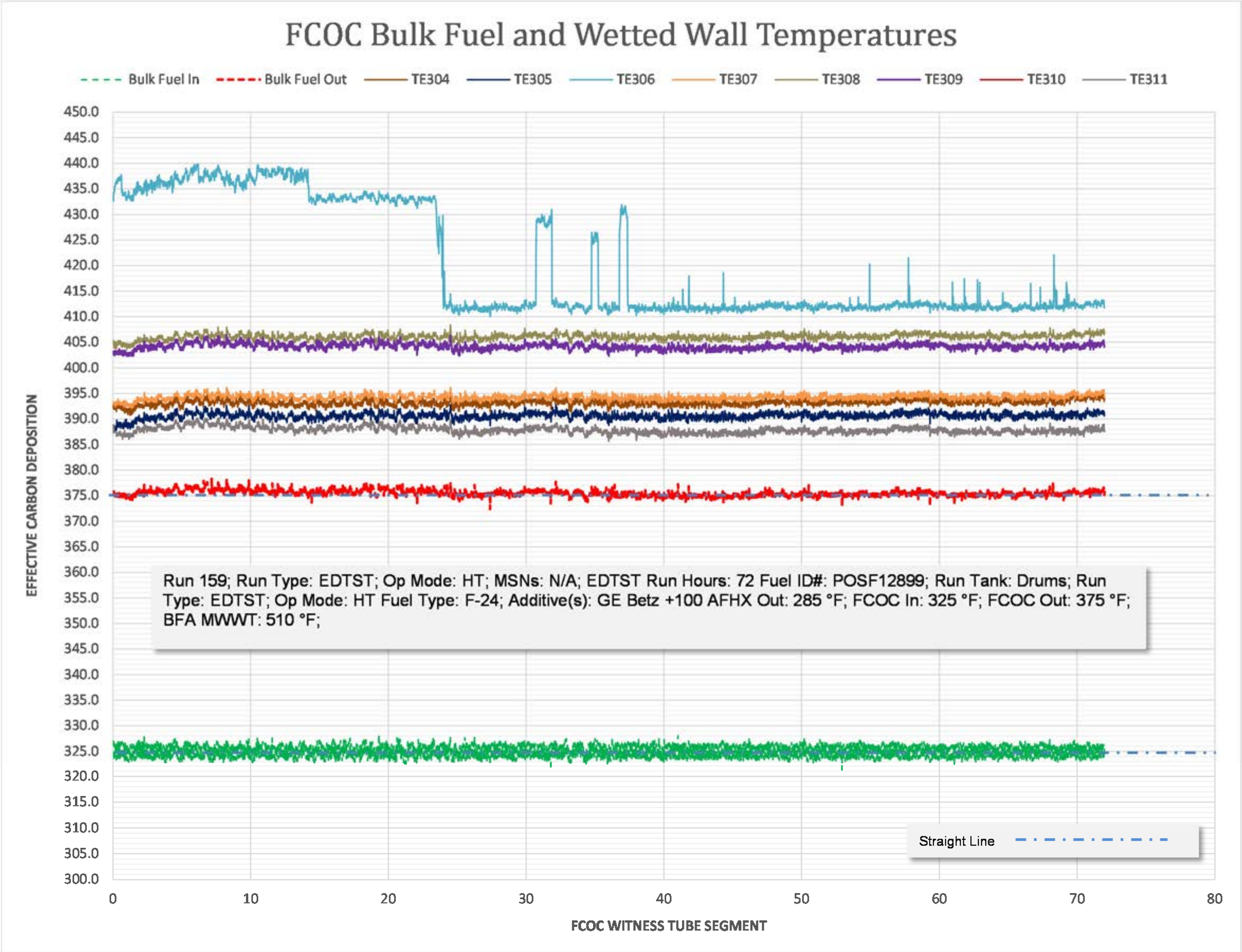


Figure N - 2 FCOC Bulk Fuel and Wetted Wall Temperatures

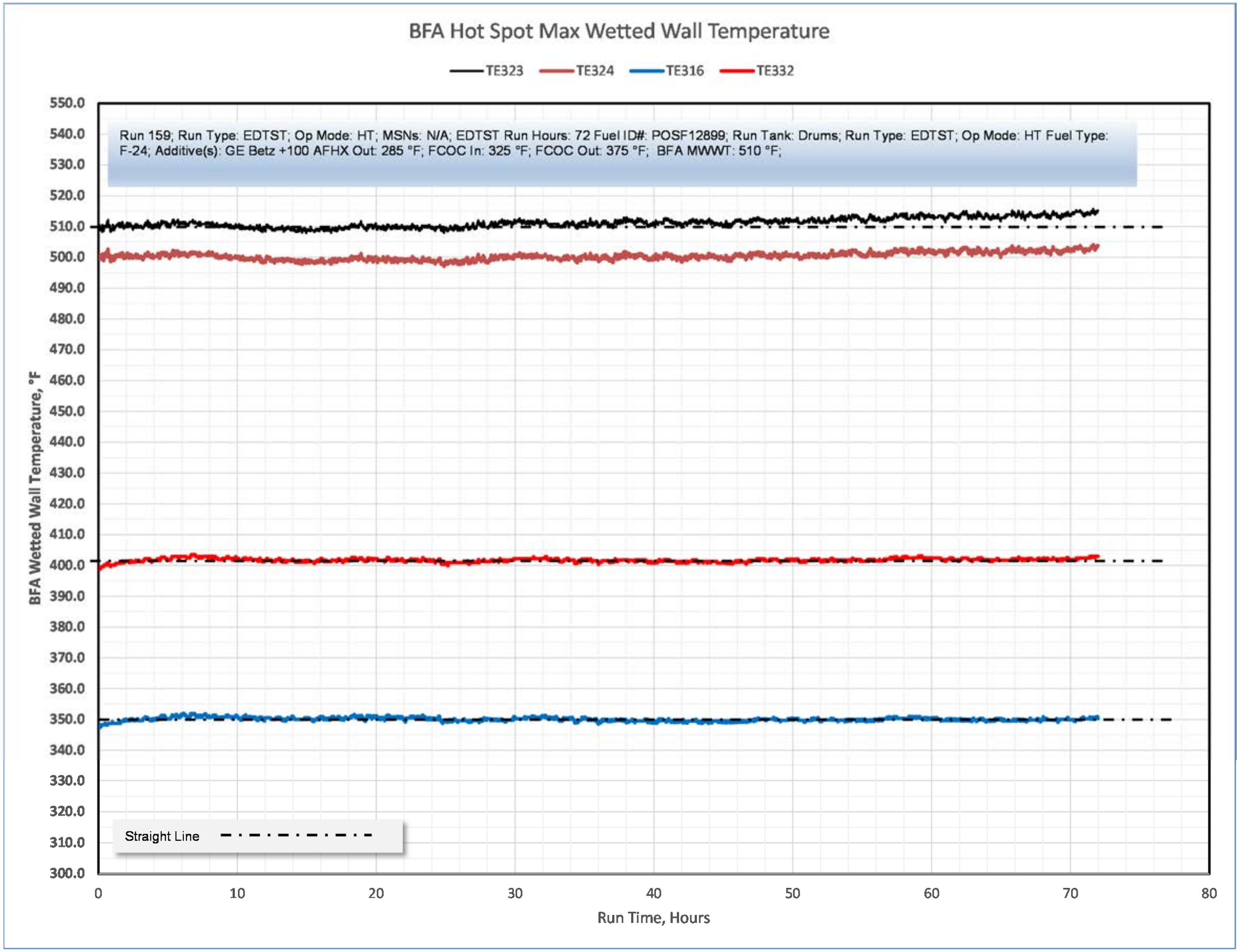


Figure N - 3 BFA Hot Spot Max Wetted Wall And Bulk Fuel Temperatures

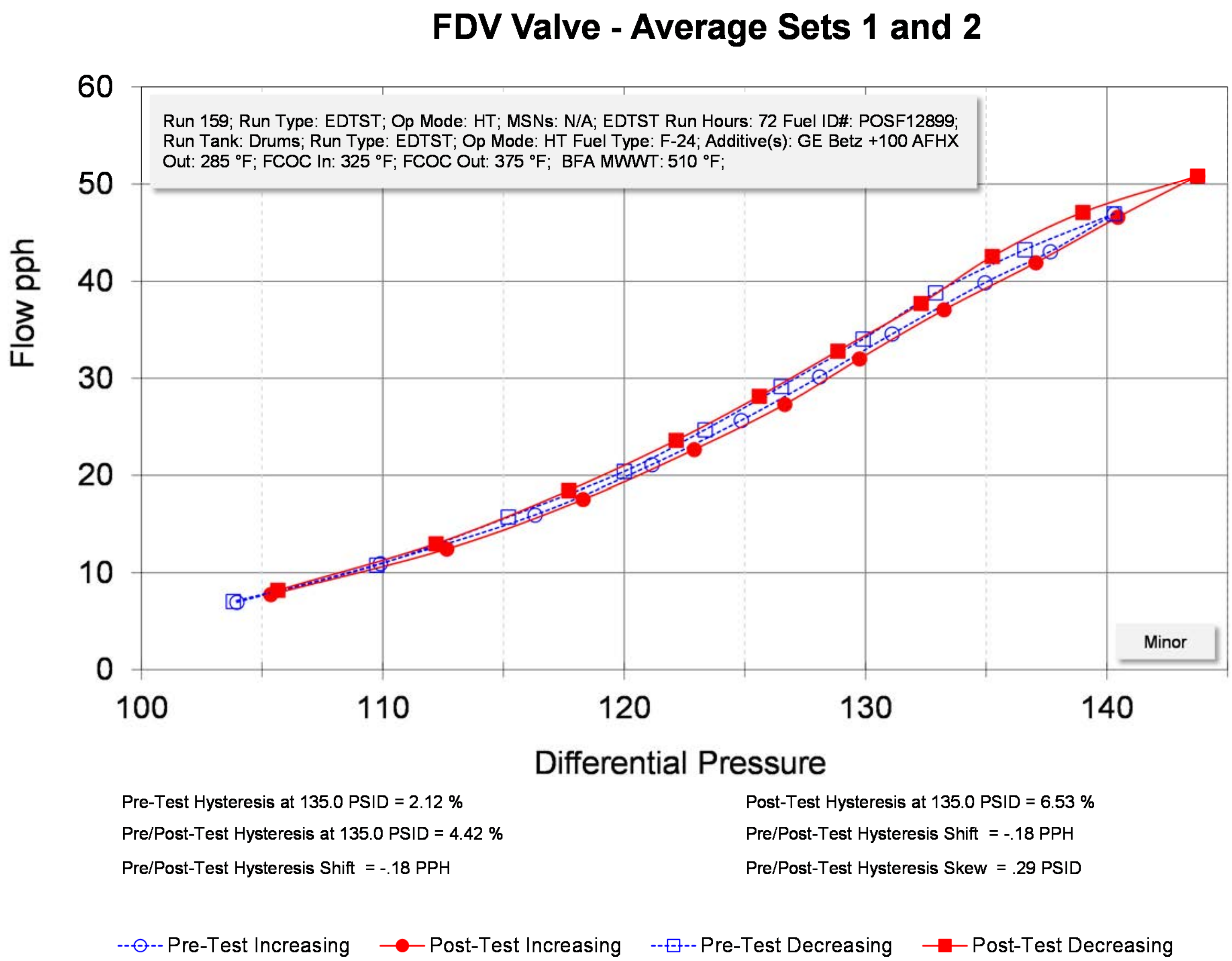


Figure N - 4 FDV Hysteresis

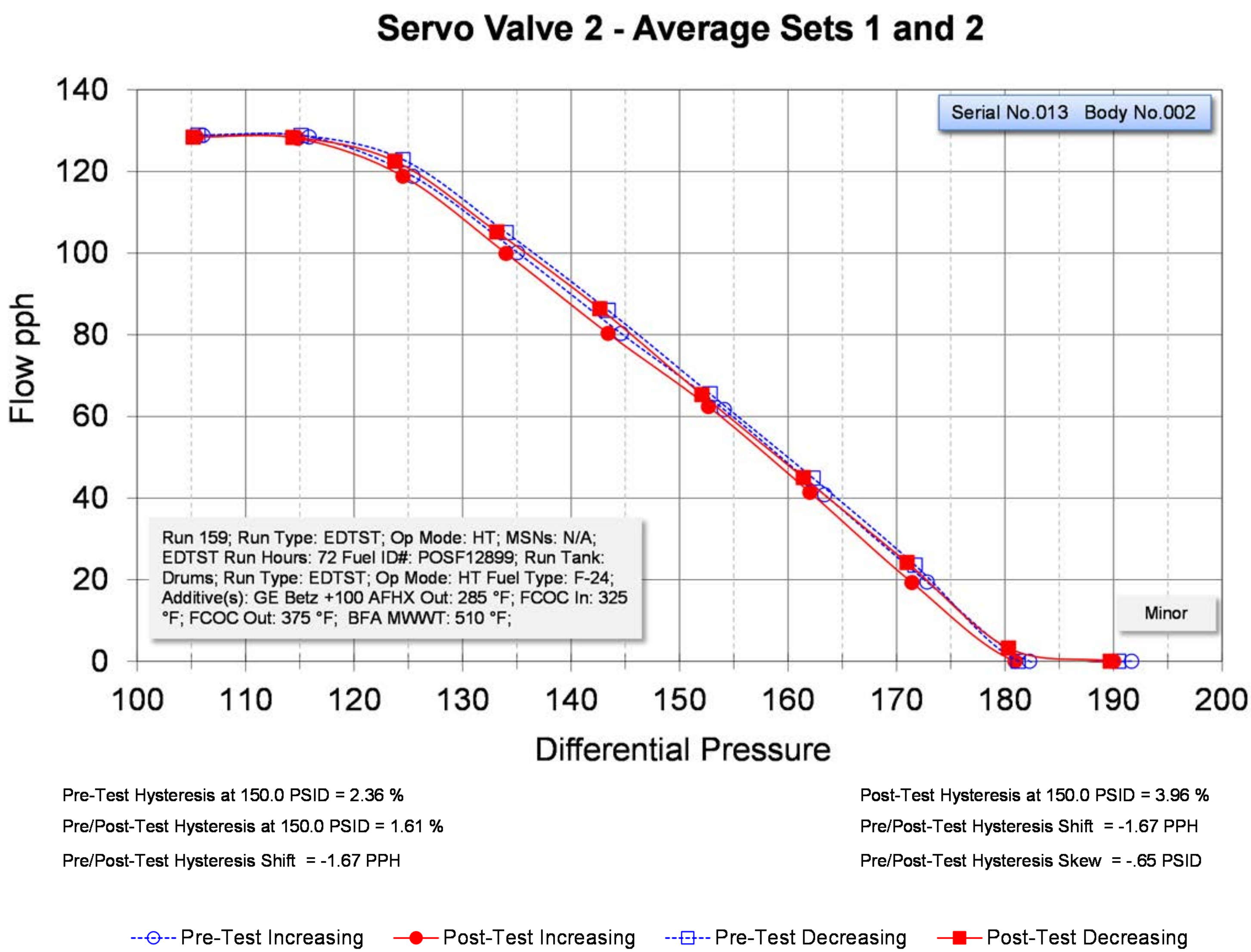
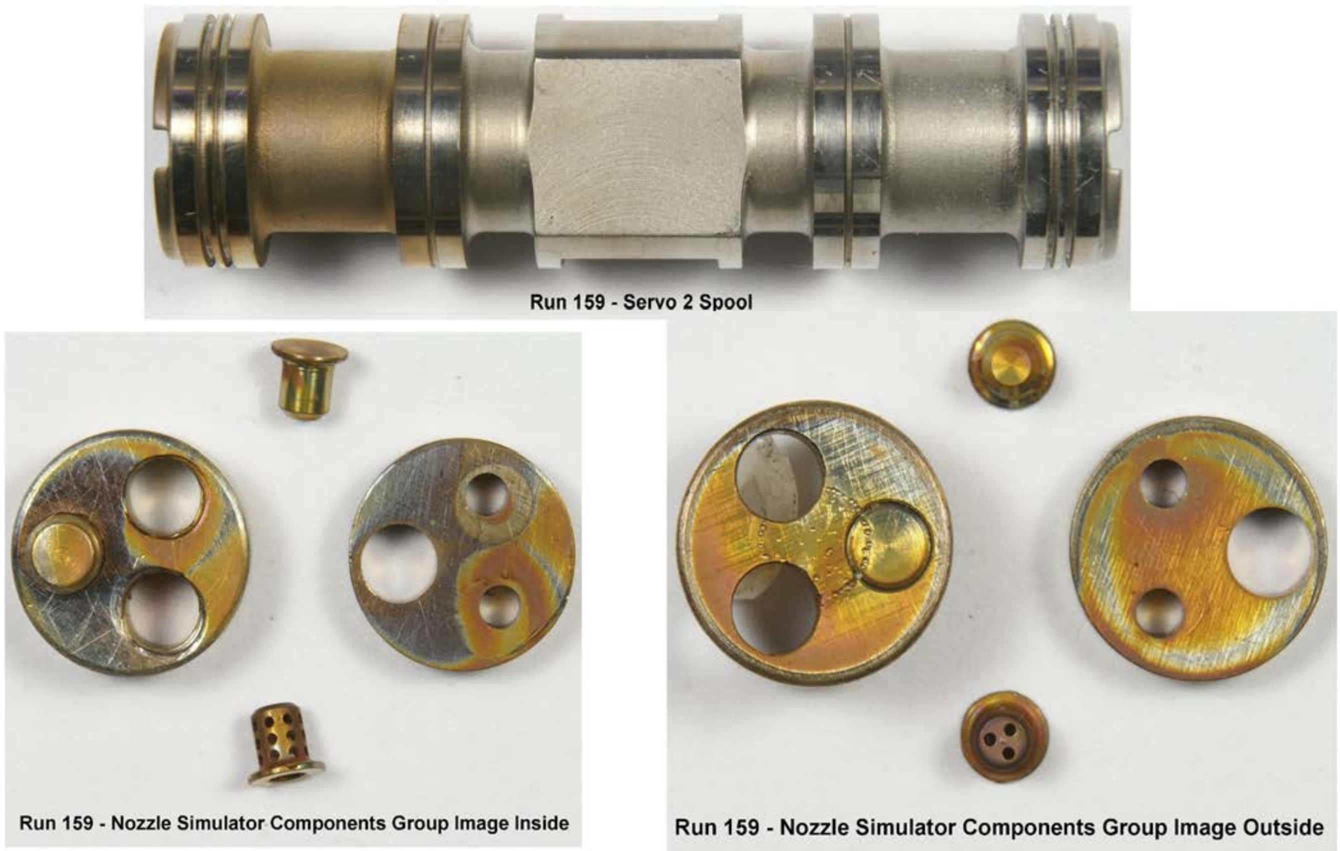


Figure N - 5 Servo Valve Hysteresis

FDV Components Comparison to Clean
Run 159

Figure N - 6 FDV Components - Comparison to Clean

Servo Valve and Nozzle Simulator Components – Run 159



Run 159 POSF-12843 HT +100

Figure N - 7 Servo Valve and Nozzle Screen Components - Comparison to Clean

TMS Screens Comparison to Clean - Run 159

Figure N - 8 TMS Screen Top and Bottom - Comparison to Clean

GCxGC Results

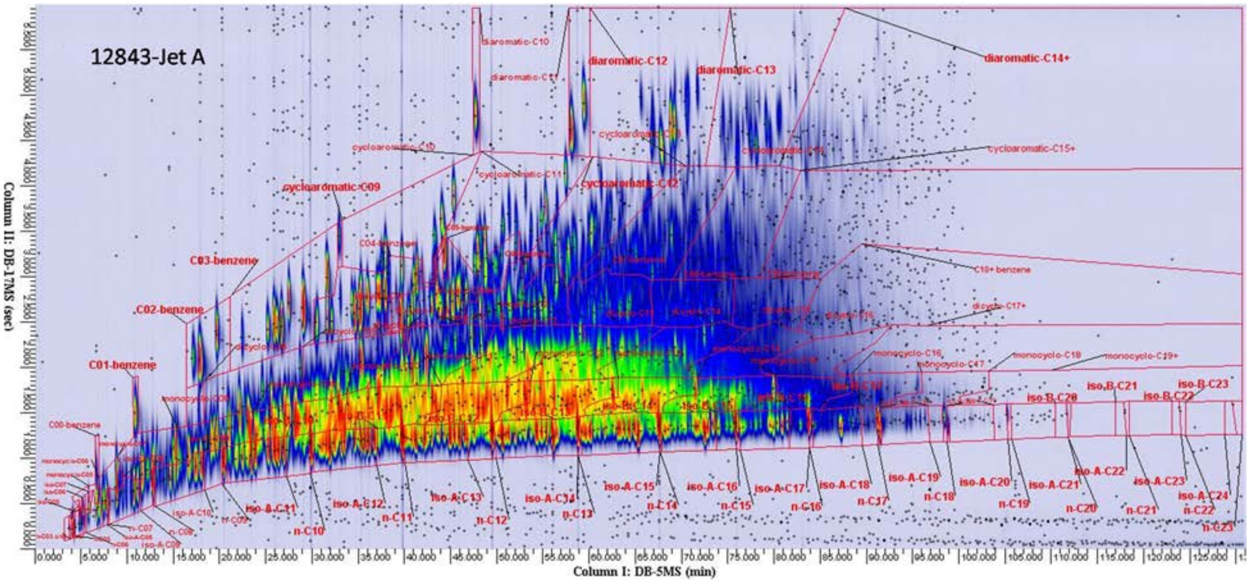


Figure N - 9 GCxGC Summary POSF-12843 Neat Fuel

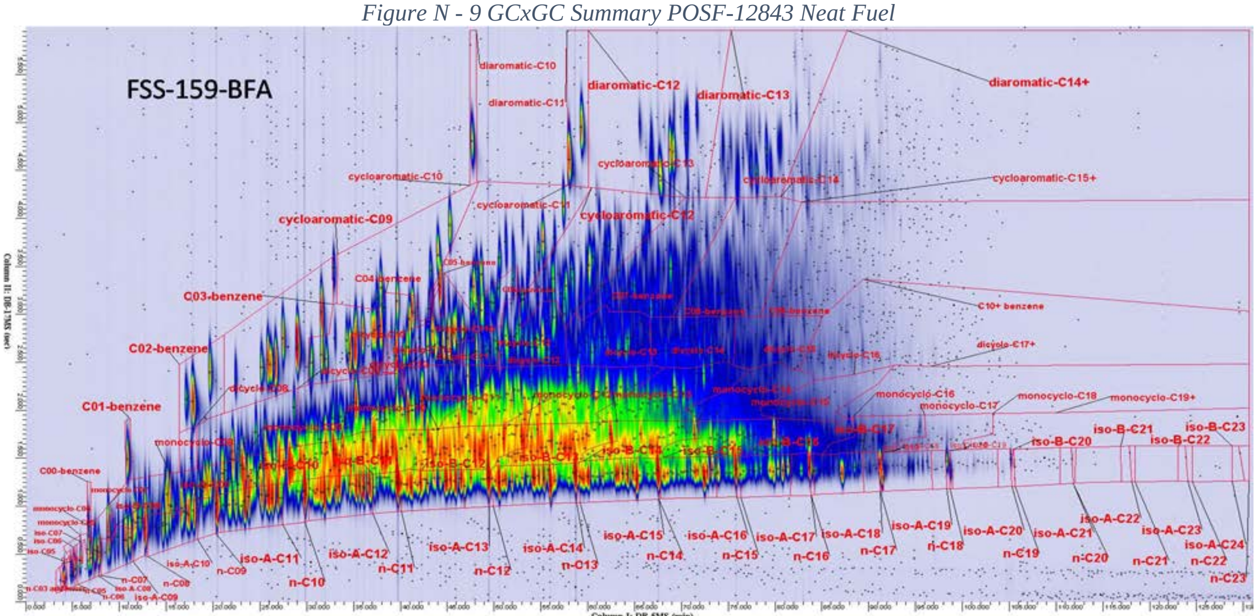


Figure N - 10 GCxGC Summary POSF-12843 BFA Outlet

Table N - 1 GCxGC Tabulated Data POSF-12843 Jet A Neat and Run 155 BFA Outlet

GCxGC Summary					
Hydrogen content (weight %)	13.9			13.9	
Average Molecular Wt (g/mole)	163			163	
	POSF-12843- Jet A			**12899-FSS159-BFA**	
	Weight %	**Volume %**		**Weight %**	**Volume %**
Aromatics					
Alkylbenzenes					
benzene (C06)	<0.01	<0.01		<0.01	<0.01
toluene (C07)	0.12	0.11		0.11	0.10
C2-benzene (C08)	0.56	0.52		0.55	0.51
C3-benzene (C09)	1.90	1.77		1.88	1.75
C4-benzene (C10)	2.45	2.29		2.48	2.30
C5-benzene (C11)	1.86	1.72		1.82	1.68
C6-benzene (C12)	1.62	1.51		1.57	1.46
C7-benzene (C13)	1.00	0.93		0.93	0.86
C8-benzene (C14)	0.83	0.77		0.84	0.78
C9-benzene (C15)	0.59	0.55		0.59	0.56
C10+-benzene (C16+)	0.40	0.37		0.37	0.35
Total Alkylbenzenes	**11.35**	10.56		**11.14**	10.36
Diaromatics (Naphthalenes, Biphenyls, etc.)					
diaromatic-C10	0.11	0.08		0.10	0.08
diaromatic-C11	0.42	0.33		0.41	0.33
diaromatic-C12	0.73	0.58		0.71	0.57
diaromatic-C13	0.51	0.42		0.51	0.41
diaromatic-C14+	0.31	0.26		0.29	0.24
Total Alkylnaphthalenes	**2.08**	1.67		**2.02**	1.63
Cycloaromatics (Indans, Tetralins,etc.)					
cycloaromatic-C09	0.04	0.04		0.04	0.04
cycloaromatic-C10	0.37	0.30		0.37	0.31
cycloaromatic-C11	0.87	0.75		0.88	0.75
cycloaromatic-C12	1.16	1.01		1.21	1.05
cycloaromatic-C13	1.47	1.29		1.51	1.32
cycloaromatic-C14	0.83	0.73		0.87	0.76
cycloaromatics-C15+	0.41	0.36		0.43	0.38
Total Cycloaromatics	**5.16**	4.47		**5.30**	4.59
Total Aromatics	**18.59**	**16.70**		**18.47**	**16.58**
Paraffins					
iso-Paraffins					
C07 & lower -isoparaffins	0.22	0.27		0.19	0.23
C08-isoparaffins	0.44	0.50		0.43	0.49
C09-isoparaffins	0.84	0.94		0.82	0.92
C10-isoparaffins	3.27	3.60		3.31	3.65
C11-isoparaffins	4.25	4.59		4.36	4.70
C12-isoparaffins	3.56	3.85		3.69	3.99
C13-isoparaffins	3.40	3.59		3.29	3.48
C14-isoparaffins	3.18	3.34		3.15	3.30
C15-isoparaffins	2.29	2.39		2.45	2.56
C16-isoparaffins	1.06	1.10		1.06	1.09
C17-isoparaffins	0.56	0.58		0.51	0.52
C18-isoparaffins	0.15	0.15		0.14	0.14
C19-isoparaffins	0.08	0.08		0.09	0.09
C20-isoparaffins	0.03	0.03		0.03	0.03
C21-isoparaffins	<0.01	<0.01		<0.01	<0.01
C22-isoparaffins	<0.01	<0.01		<0.01	<0.01
C23-isoparaffins	<0.01	<0.01		<0.01	<0.01
C24-isoparaffins	<0.01	<0.01		<0.01	<0.01
Total iso-Paraffins	**23.31**	25.01		**23.57**	25.27

n-Paraffins					
n-C07 & lower	0.17	0.20		0.17	0.20
n-C08	0.43	0.49		0.42	0.48
n-C09	1.01	1.13		1.00	1.12
n-C10	2.54	2.79		2.54	2.79
n-C11	3.01	3.26		2.99	3.24
n-C12	2.52	2.70		2.52	2.69
n-C13	2.00	2.12		2.01	2.13
n-C14	1.54	1.62		1.51	1.58
n-C15	0.89	0.93		0.89	0.93
n-C16	0.43	0.44		0.42	0.44
n-C17	0.20	0.20		0.18	0.19
n-C18	0.04	0.04		0.04	0.04
n-C19	<0.01	<0.01		<0.01	<0.01
n-C20	<0.01	<0.01		<0.01	<0.01
n-C21	<0.01	<0.01		<0.01	<0.01
n-C22	<0.01	<0.01		<0.01	<0.01
n-C23	<0.01	<0.01		<0.01	<0.01
Total n-Paraffins	**14.80**	15.93		**14.71**	15.82
Cycloparaffins					
Monocycloparaffins					
C07 & lower monocycloparaffins	0.42	0.43		0.42	0.43
C08-monocyclocycloparaffins	0.63	0.64		0.62	0.63
C09-monocyclocycloparaffins	1.82	1.84		1.81	1.82
C10-monocyclocycloparaffins	4.60	4.50		4.59	4.49
C11-monocyclocycloparaffins	6.32	6.36		6.28	6.31
C12-monocyclocycloparaffins	5.57	5.57		5.70	5.69
C13-monocyclocycloparaffins	5.07	5.02		5.15	5.09
C14-monocyclocycloparaffins	3.15	3.12		3.25	3.22
C15-monocyclocycloparaffins	2.10	2.07		1.99	1.96
C16-monocyclocycloparaffins	0.86	0.85		1.07	1.05
C17-monocyclocycloparaffins	0.33	0.32		0.40	0.39
C18-monocyclocycloparaffins	0.05	0.05		0.06	0.05
C19+-monocyclocycloparaffins	<0.01	<0.01		0.01	0.01
Total Monocycloparaffins	**30.93**	30.78		**31.34**	31.17
Dicycloparaffins					
C08-dicycloparaffins	0.02	0.02		0.02	0.02
C09-dicycloparaffins	0.45	0.42		0.54	0.50
C10-dicycloparaffins	1.01	0.90		1.00	0.89
C11-dicycloparaffins	2.32	2.17		2.11	1.98
C12-dicycloparaffins	2.69	2.54		2.61	2.46
C13-dicycloparaffins	3.00	2.83		3.08	2.90
C14-dicycloparaffins	1.94	1.83		1.93	1.82
C15-dicycloparaffins	0.60	0.56		0.57	0.54
C16-dicycloparaffins	0.21	0.20		0.08	0.07
C17+-dicycloparaffins	0.04	0.03		0.02	0.02
Total Dicycloparaffins	**12.27**	11.51		**11.96**	11.21
Tricycloparaffins					
C10-tricycloparaffins	<0.01	<0.01		<0.01	<0.01
C11-tricycloparaffins	0.09	0.07		0.09	0.08
C12-tricycloparaffins	<0.01	<0.01		<0.01	<0.01
Total Tricycloparaffins	**0.09**	0.08		**0.09**	0.08
Total Cycloparaffins	**43.29**	42.36		**43.40**	42.46
Average Molecular Formula - C	11.7			11.7	
Average Molecular Formula - H	22.4			22.4	

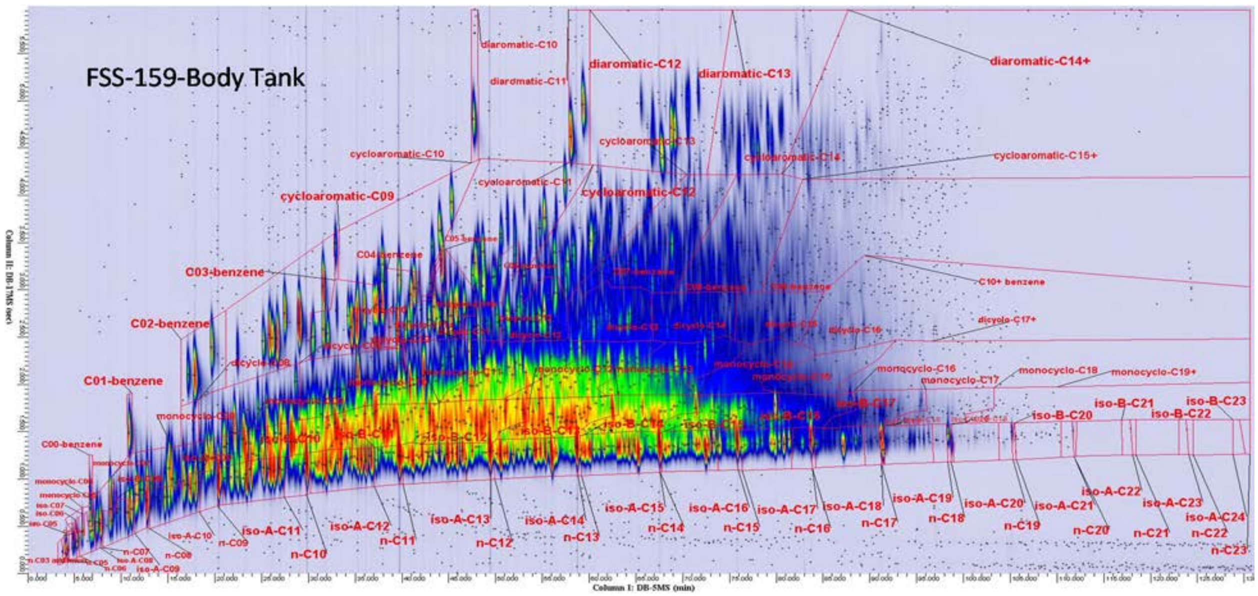


Figure N - 11 GCxGC Summary Fuel From Body Tank

Table N - 2 GCxGC Tabulated Data - Fuel From Body Tank at the End Of Run

GCxGC Summary				
Hydrogen content (weight %)	**13.9**		**13.9**	
Average Molecular Wt (g/mole)	**163**		**163**	
	POSF-12843- Jet A		**12899-FSS159-Body Tank**	
	Weight %	**Volume %**	**Weight %**	**Volume %**
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	<0.01	<0.01
toluene (C07)	0.12	0.11	0.11	0.10
C2-benzene (C08)	0.56	0.52	0.55	0.51
C3-benzene (C09)	1.90	1.77	1.86	1.73
C4-benzene (C10)	2.45	2.29	2.46	2.29
C5-benzene (C11)	1.86	1.72	1.82	1.69
C6-benzene (C12)	1.62	1.51	1.57	1.46
C7-benzene (C13)	1.00	0.93	0.93	0.87
C8-benzene (C14)	0.83	0.77	0.88	0.82
C9-benzene (C15)	0.59	0.55	0.60	0.56
C10+-benzene (C16+)	0.40	0.37	0.38	0.35
Total Alkylbenzenes	**11.35**	10.56	**11.17**	10.39
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.10	0.08
diaromatic-C11	0.42	0.33	0.41	0.33
diaromatic-C12	0.73	0.58	0.71	0.57
diaromatic-C13	0.51	0.42	0.50	0.41
diaromatic-C14+	0.31	0.26	0.28	0.23
Total Alkylnaphthalenes	**2.08**	1.67	**2.01**	1.62
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.04	0.04	0.04	0.04
cycloaromatic-C10	0.37	0.30	0.37	0.31
cycloaromatic-C11	0.87	0.75	0.91	0.78
cycloaromatic-C12	1.16	1.01	1.24	1.07
cycloaromatic-C13	1.47	1.29	1.48	1.29
cycloaromatic-C14	0.83	0.73	0.82	0.72
cycloaromatics-C15+	0.41	0.36	0.41	0.36
Total Cycloaromatics	**5.16**	4.47	**5.28**	4.57
Total Aromatics	**18.59**	**16.70**	**18.46**	**16.57**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.22	0.27	0.19	0.23
C08-isoparaffins	0.44	0.50	0.43	0.49
C09-isoparaffins	0.84	0.94	0.81	0.91
C10-isoparaffins	3.27	3.60	3.25	3.59
C11-isoparaffins	4.25	4.59	4.35	4.69
C12-isoparaffins	3.56	3.85	3.70	4.00
C13-isoparaffins	3.40	3.59	3.38	3.58
C14-isoparaffins	3.18	3.34	3.20	3.36
C15-isoparaffins	2.29	2.39	2.46	2.56
C16-isoparaffins	1.06	1.10	1.07	1.11
C17-isoparaffins	0.56	0.58	0.50	0.52
C18-isoparaffins	0.15	0.15	0.14	0.14
C19-isoparaffins	0.08	0.08	0.09	0.09
C20-isoparaffins	0.03	0.03	0.03	0.03
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01
Total iso-Paraffins	**23.31**	25.01	**23.49**	25.19

n-Paraffins				
n-C07 & lower	0.17	0.20	0.17	0.20
n-C08	0.43	0.49	0.42	0.48
n-C09	1.01	1.13	1.00	1.12
n-C10	2.54	2.79	2.53	2.78
n-C11	3.01	3.26	3.01	3.25
n-C12	2.52	2.70	2.67	2.84
n-C13	2.00	2.12	2.01	2.13
n-C14	1.54	1.62	1.51	1.59
n-C15	0.89	0.93	0.89	0.93
n-C16	0.43	0.44	0.42	0.44
n-C17	0.20	0.20	0.18	0.19
n-C18	0.04	0.04	0.03	0.04
n-C19	<0.01	<0.01	<0.01	<0.01
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**14.80**	15.93	**14.87**	15.99
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.42	0.43	0.42	0.44
C08-monocyclocycloparaffins	0.63	0.64	0.61	0.62
C09-monocyclocycloparaffins	1.82	1.84	1.81	1.83
C10-monocyclocycloparaffins	4.60	4.50	4.33	4.24
C11-monocyclocycloparaffins	6.32	6.36	6.59	6.62
C12-monocyclocycloparaffins	5.57	5.57	5.52	5.52
C13-monocyclocycloparaffins	5.07	5.02	5.09	5.03
C14-monocyclocycloparaffins	3.15	3.12	3.25	3.22
C15-monocyclocycloparaffins	2.10	2.07	2.02	2.00
C16-monocyclocycloparaffins	0.86	0.85	0.91	0.90
C17-monocyclocycloparaffins	0.33	0.32	0.39	0.39
C18-monocyclocycloparaffins	0.05	0.05	0.07	0.07
C19+-monocyclocycloparaffins	<0.01	<0.01	0.01	<0.01
Total Monocycloparaffins	**30.93**	30.78	**31.04**	30.87
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.45	0.42	0.53	0.49
C10-dicycloparaffins	1.01	0.90	1.01	0.90
C11-dicycloparaffins	2.32	2.17	2.13	2.00
C12-dicycloparaffins	2.69	2.54	2.74	2.58
C13-dicycloparaffins	3.00	2.83	2.96	2.79
C14-dicycloparaffins	1.94	1.83	1.99	1.88
C15-dicycloparaffins	0.60	0.56	0.61	0.58
C16-dicycloparaffins	0.21	0.20	0.20	0.19
C17+-dicycloparaffins	0.04	0.03	0.02	0.02
Total Dicycloparaffins	**12.27**	11.51	**12.22**	11.45
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.09	0.07	0.09	0.08
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.09**	0.08	**0.09**	0.08
Total Cycloparaffins	**43.29**	**42.36**	**43.35**	**42.40**
Average Molecular Formula - C	11.7		11.7	
Average Molecular Formula - H	22.4		22.4	

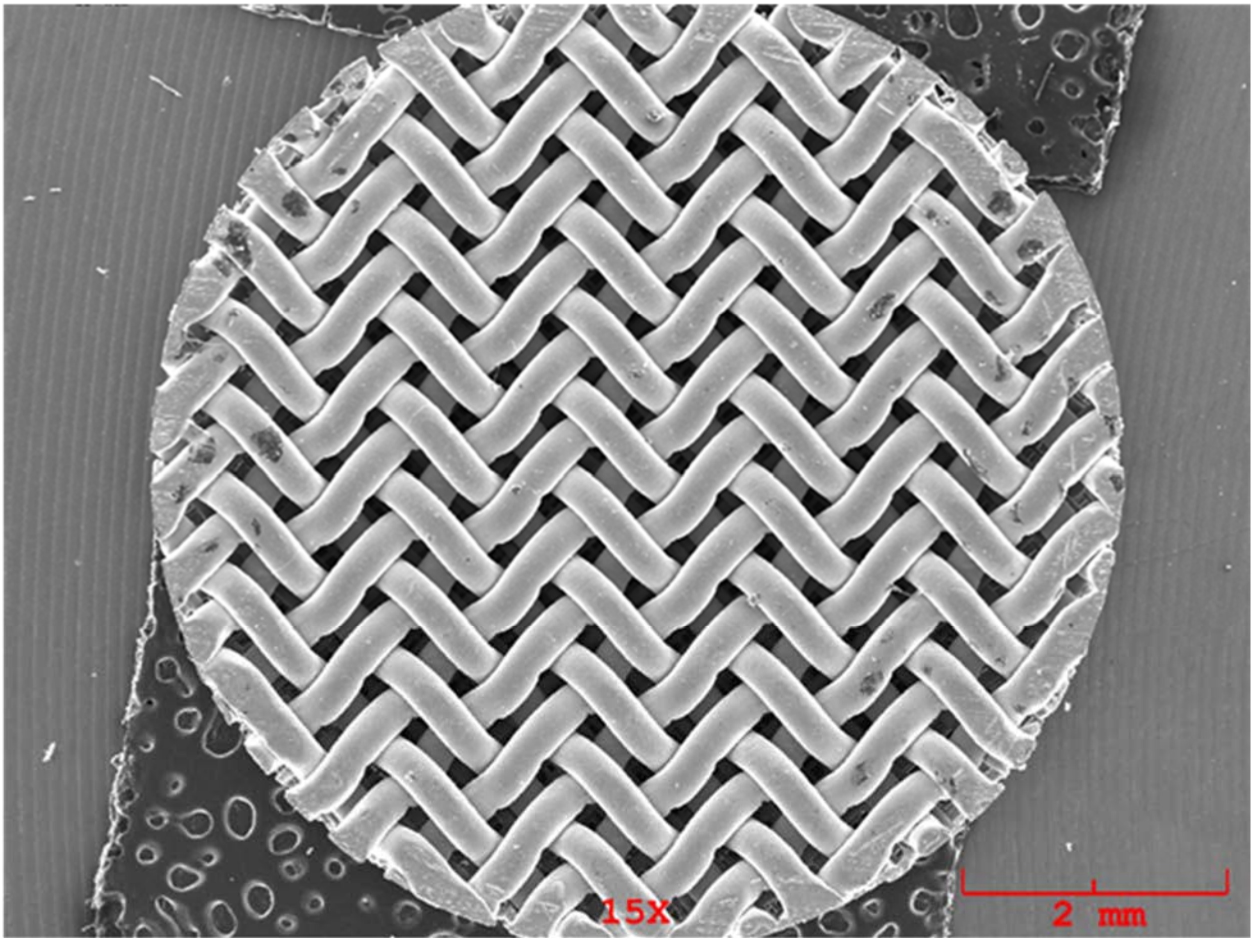
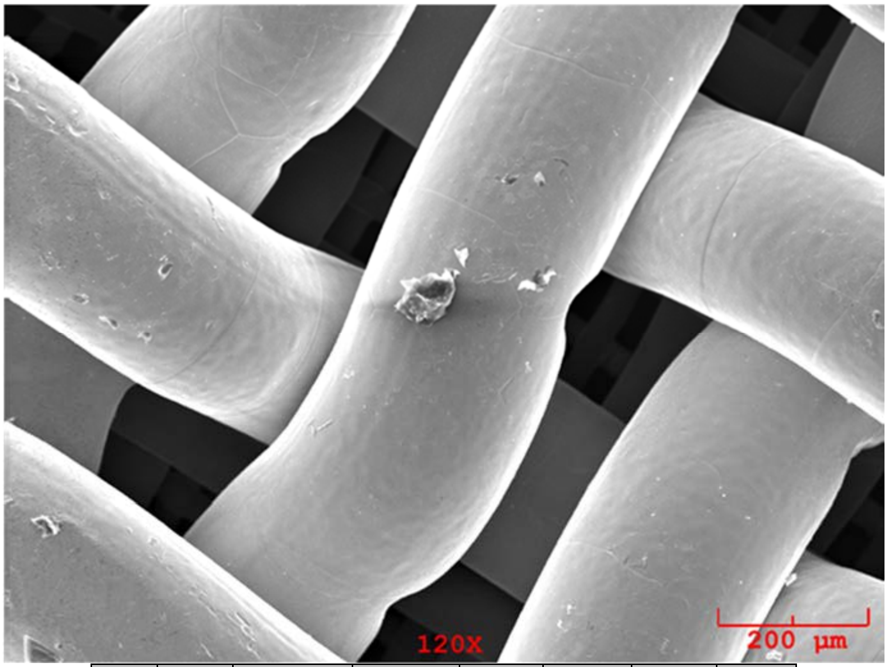


Figure N - 12 TMS Screen, Top, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	4.60	2.447	wt.%	0.401	0.504	
Al	Ka	3.98	0.544	wt.%	0.132	0.185	
Si	Ka	3.15	0.347	wt.%	0.109	0.156	
S	Ka	4.08	0.351	wt.%	0.091	0.129	
Cr	Ka	144.58	17.200	wt.%	0.309	0.178	
Mn	Ka	8.70	1.420	wt.%	0.190	0.251	
Fe	Ka	350.82	69.098	wt.%	0.761	0.287	
Ni	Ka	29.13	8.593	wt.%	0.406	0.386	
			100.000	wt.%			Total

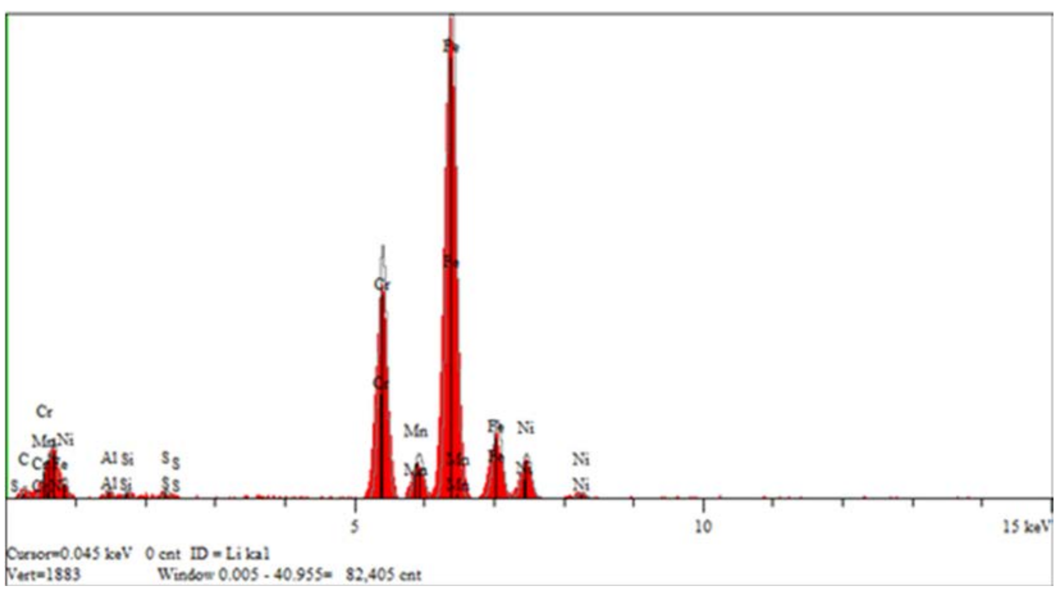


Figure N - 13 TMS Screen Top, 120X and EDX Elemental Analysis

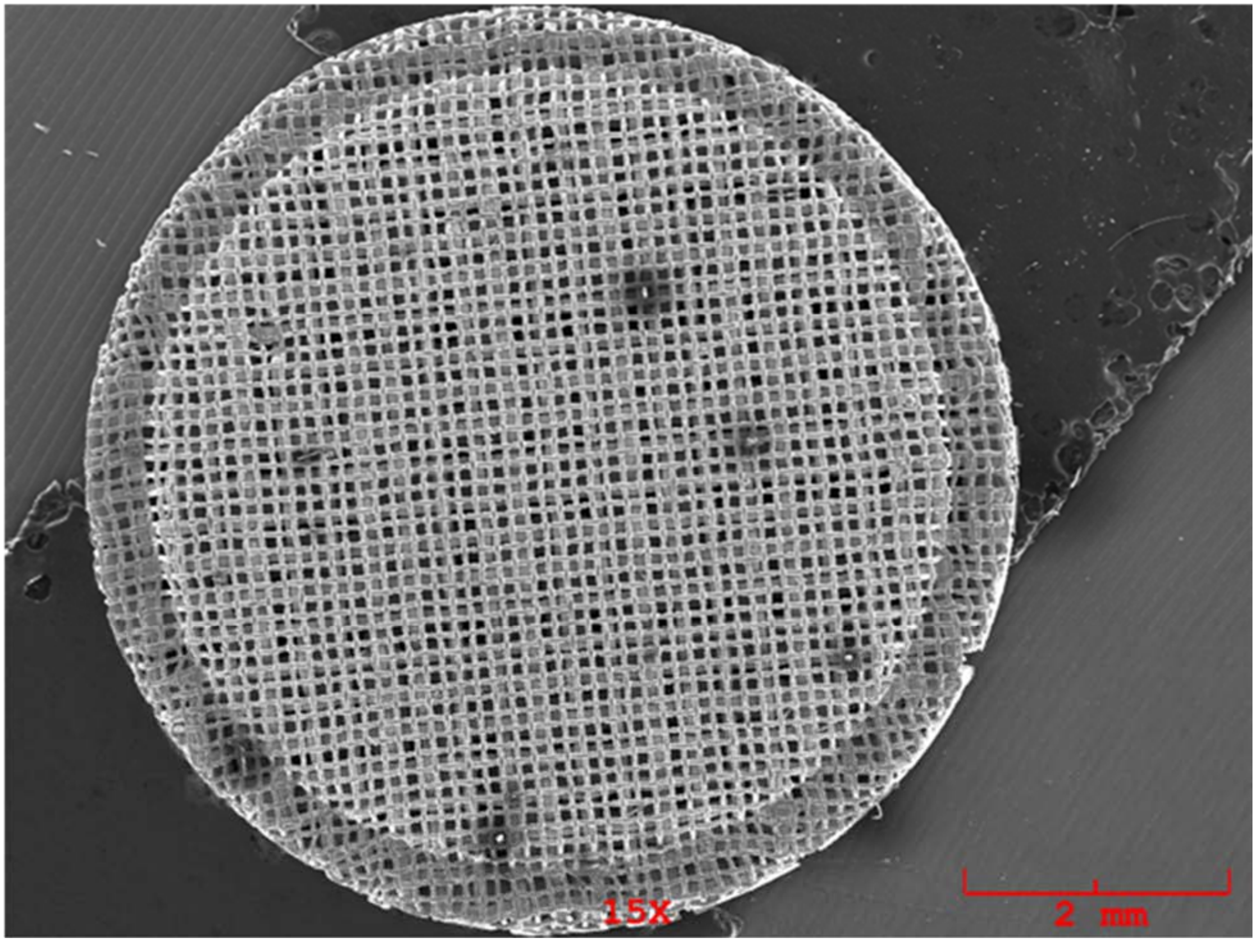
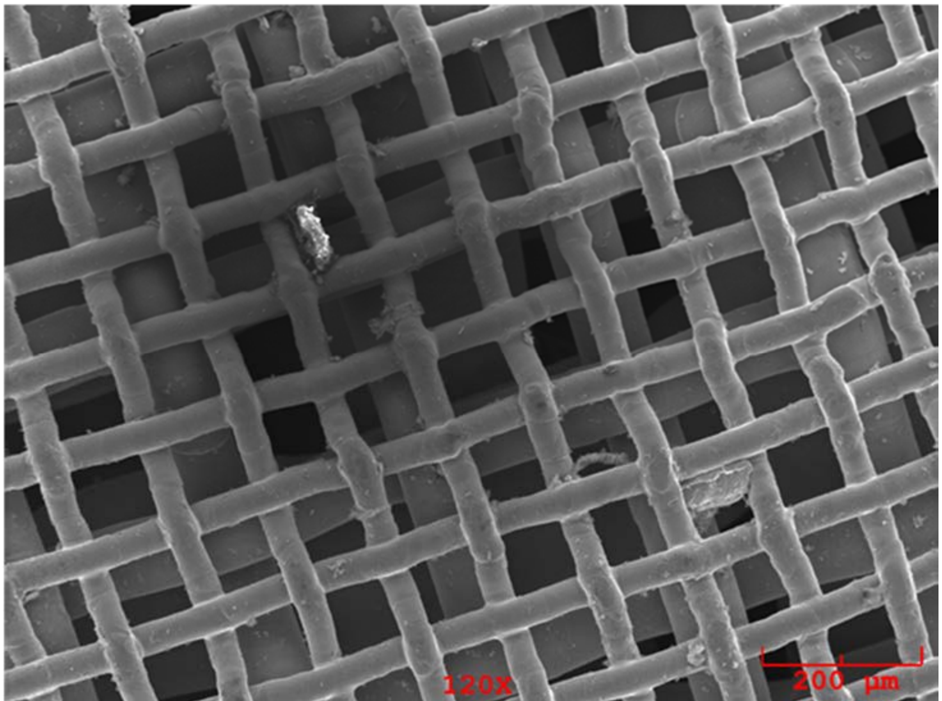


Figure N - 14 TMS Screen, Bottom, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	5.82	4.084	wt.%	0.546	0.656	
O	Ka	0.83	0.218	wt.%	0.146	0.212	
Al	Ka	3.76	0.671	wt.%	0.148	0.200	
Si	Ka	2.78	0.400	wt.%	0.123	0.174	
S	Ka	5.76	0.652	wt.%	0.111	0.148	
Cr	Ka	110.06	17.488	wt.%	0.360	0.208	
Mn	Ka	7.55	1.638	wt.%	0.225	0.292	
Fe	Ka	257.49	67.390	wt.%	0.868	0.337	
Ni	Ka	18.69	7.299	wt.%	0.434	0.417	
Zn	Ka	0.27	0.160	wt.%	0.332	0.500	
			100.000	wt.%			Total

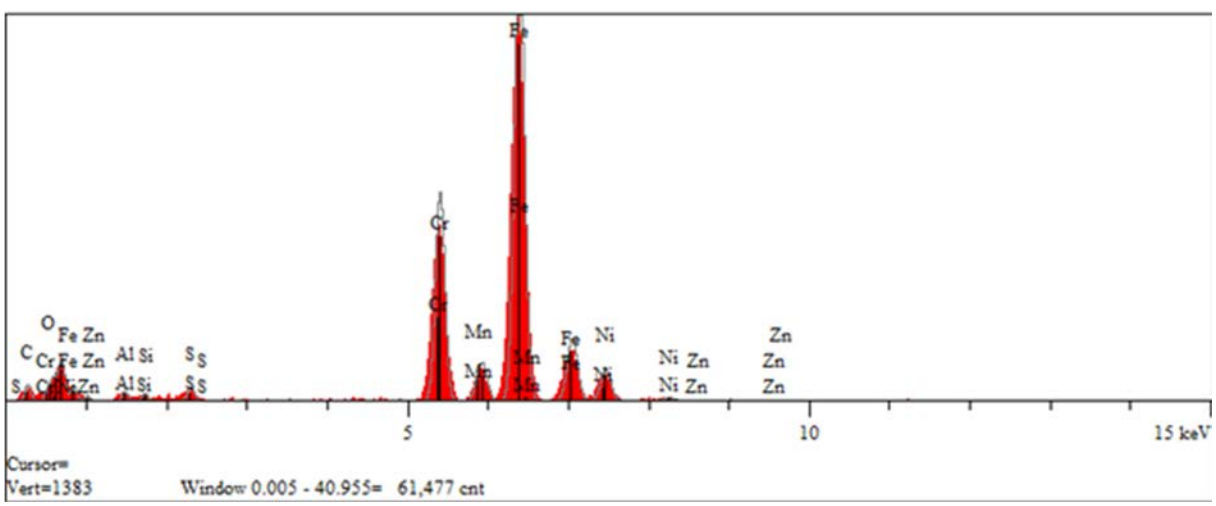


Figure N – 15 TMS Screen, Bottom, 120X and EDX Elemental Analysis

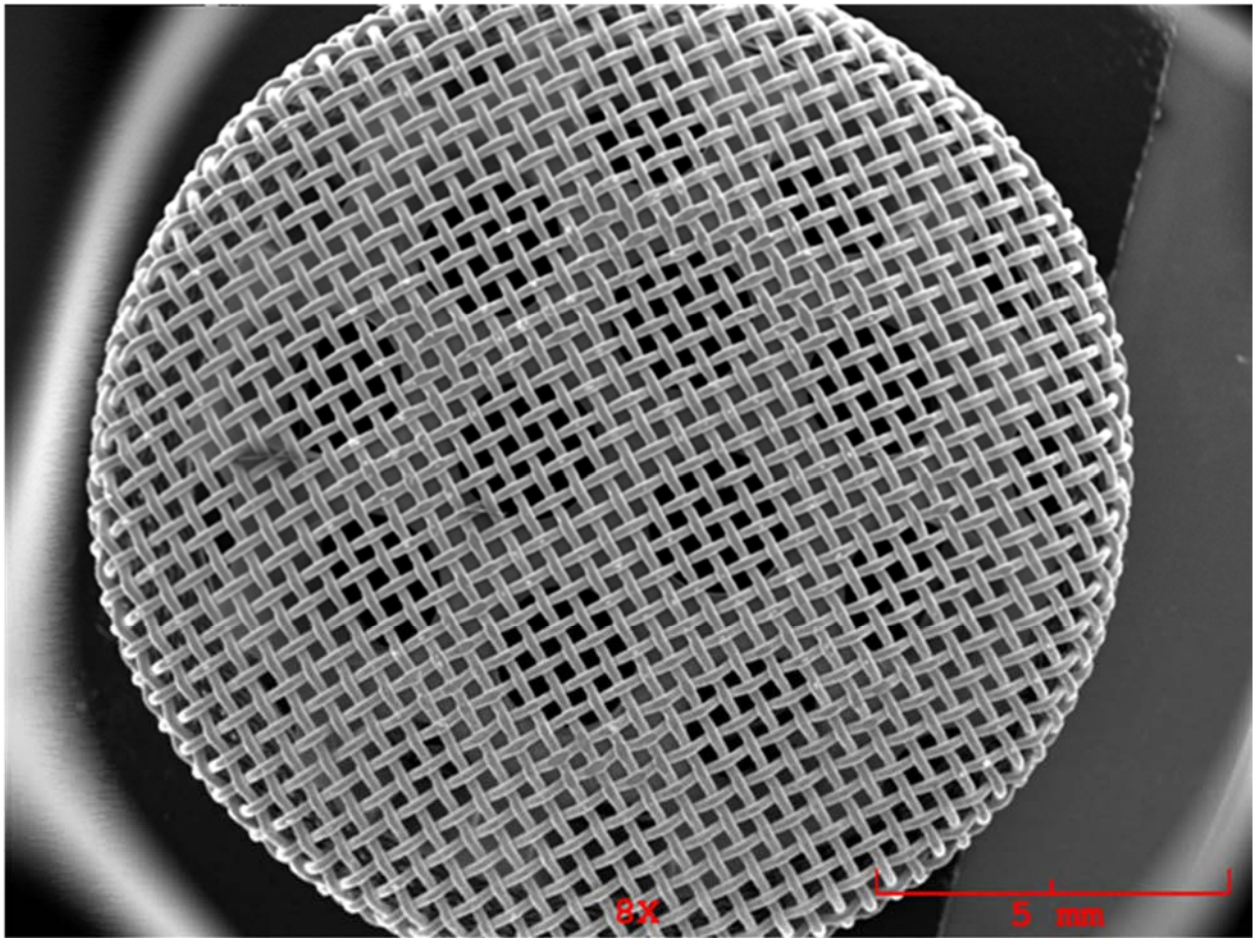
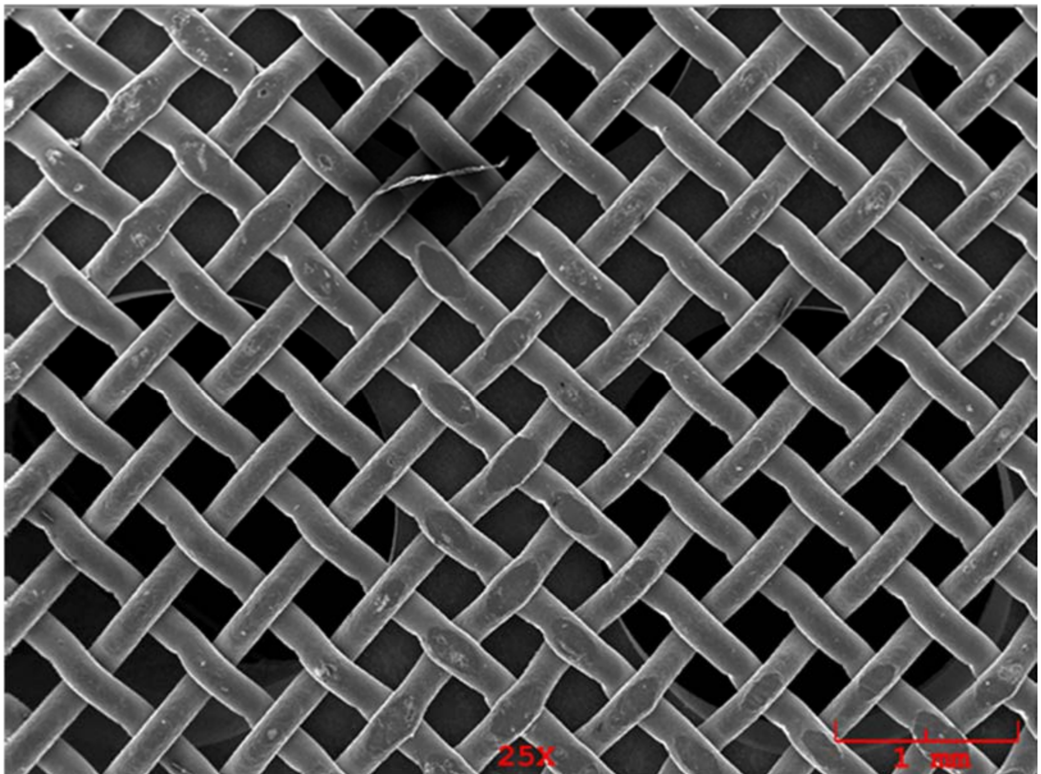


Figure N - 16 F303 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	0.45	0.335	wt.%	0.403	0.598	
Si	Ka	3.90	0.577	wt.%	0.133	0.182	
S	Ka	7.73	0.895	wt.%	0.121	0.157	
Cr	Ka	104.12	16.426	wt.%	0.351	0.213	
Mn	Ka	5.68	1.236	wt.%	0.223	0.303	
Fe	Ka	270.95	71.139	wt.%	0.892	0.339	
Ni	Ka	23.81	9.393	wt.%	0.491	0.465	
			100.000	wt.%			Total

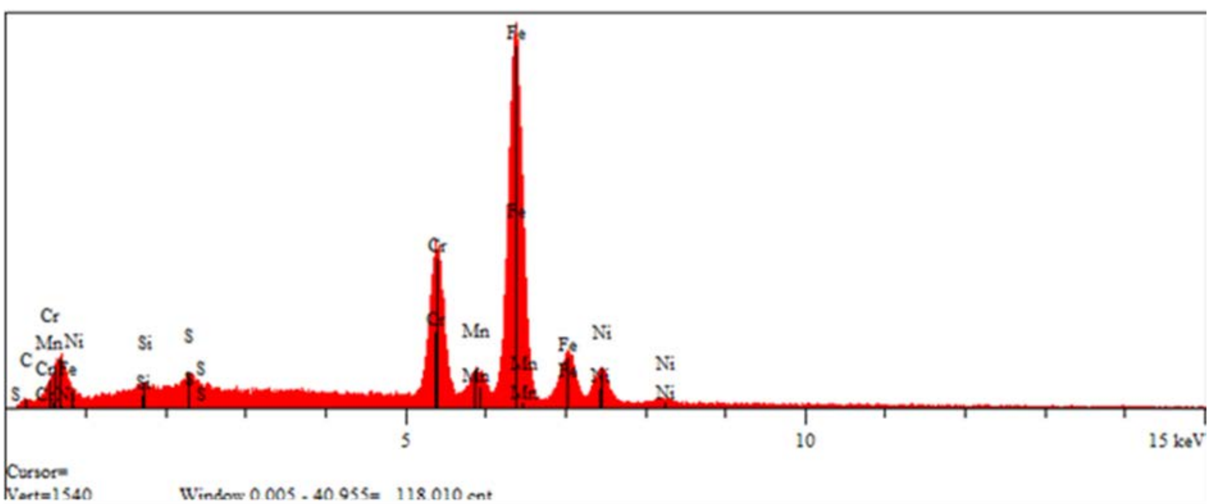


Figure N -17 F303 Bottom 25X and EDX Elemental Analysis

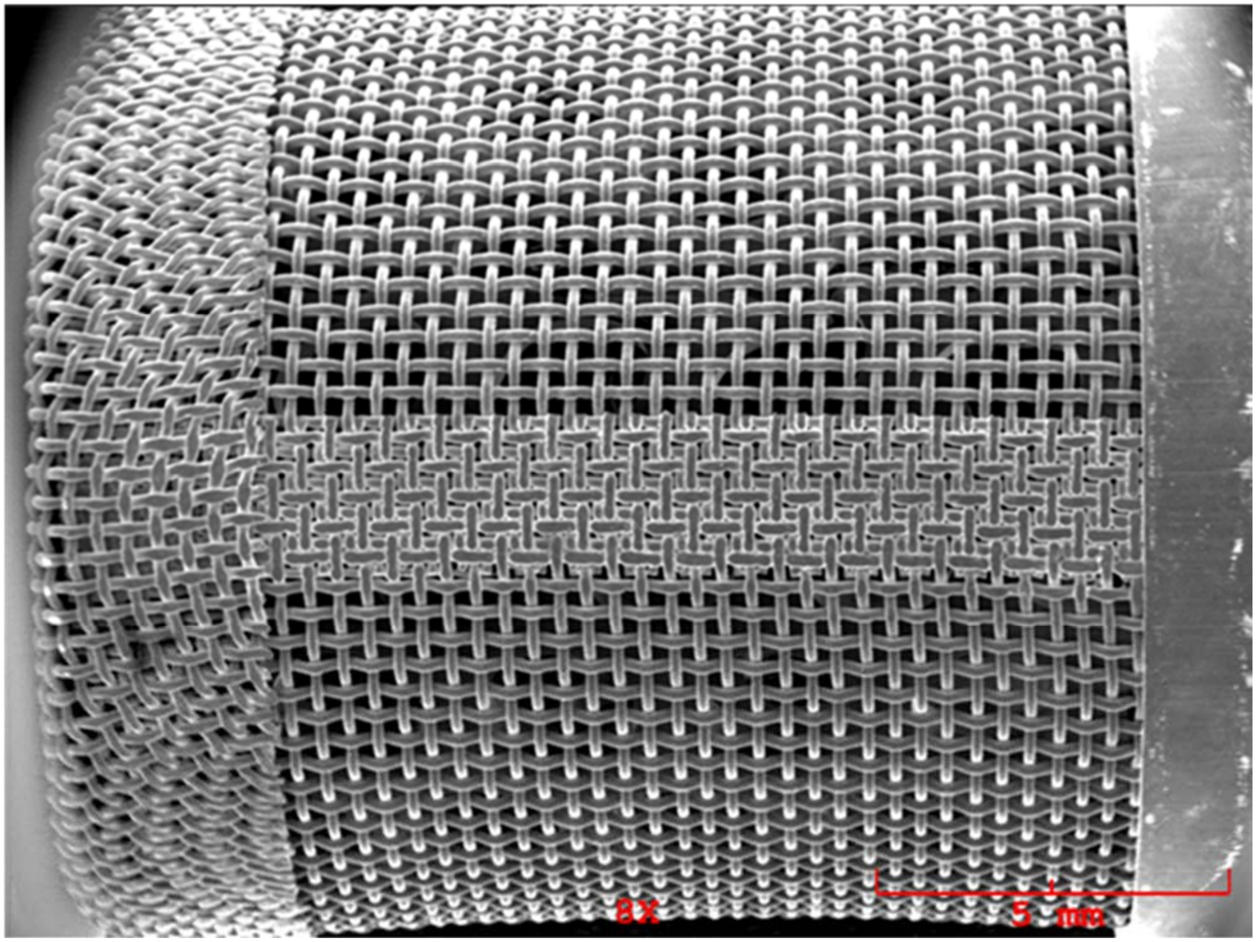
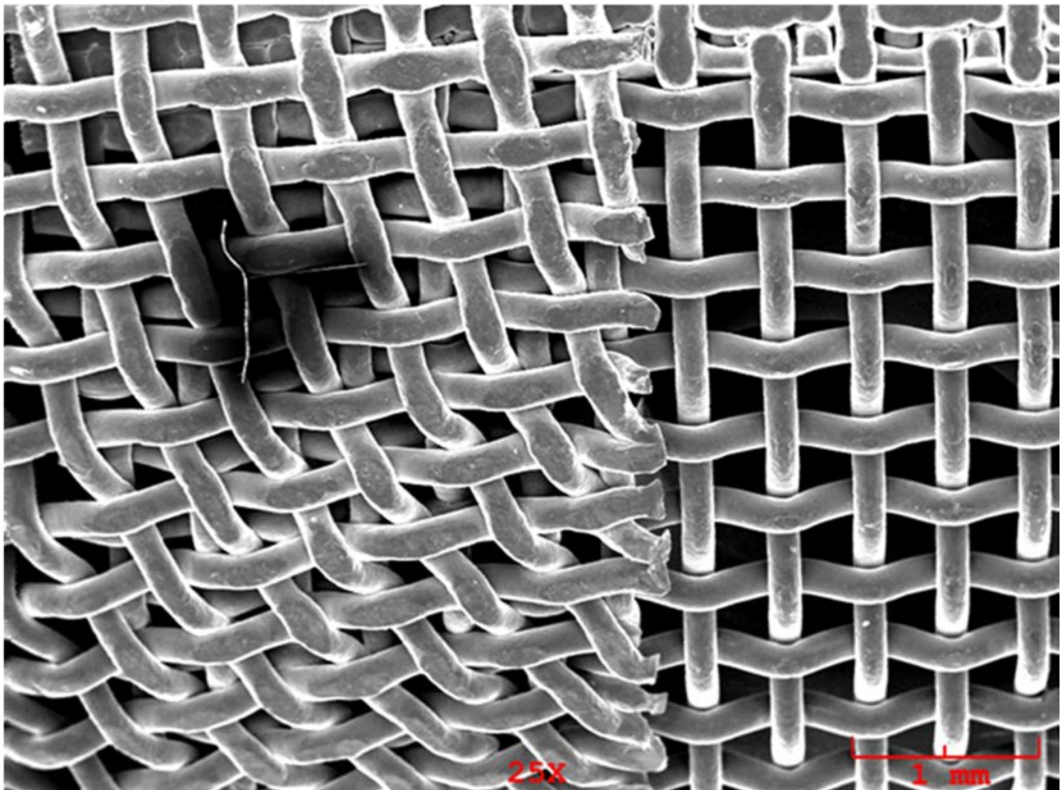


Figure N - 18 F303 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	0.56	0.503	wt.%	0.440	0.641	
Si	Ka	2.93	0.517	wt.%	0.141	0.195	
S	Ka	8.90	1.230	wt.%	0.136	0.166	
Cr	Ka	85.95	16.273	wt.%	0.381	0.228	
Mn	Ka	5.61	1.459	wt.%	0.247	0.327	
Fe	Ka	223.44	70.083	wt.%	0.972	0.390	
Ni	Ka	21.08	9.935	wt.%	0.544	0.504	
			100.000	wt.%			Total

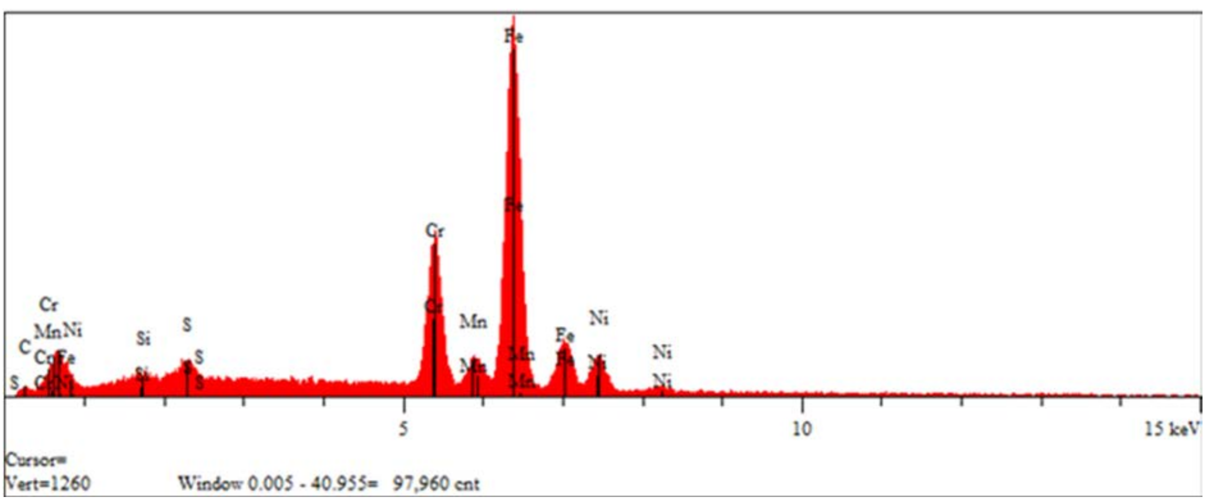


Figure N - 19 F303 Side 25X and EDX Elemental Analysis

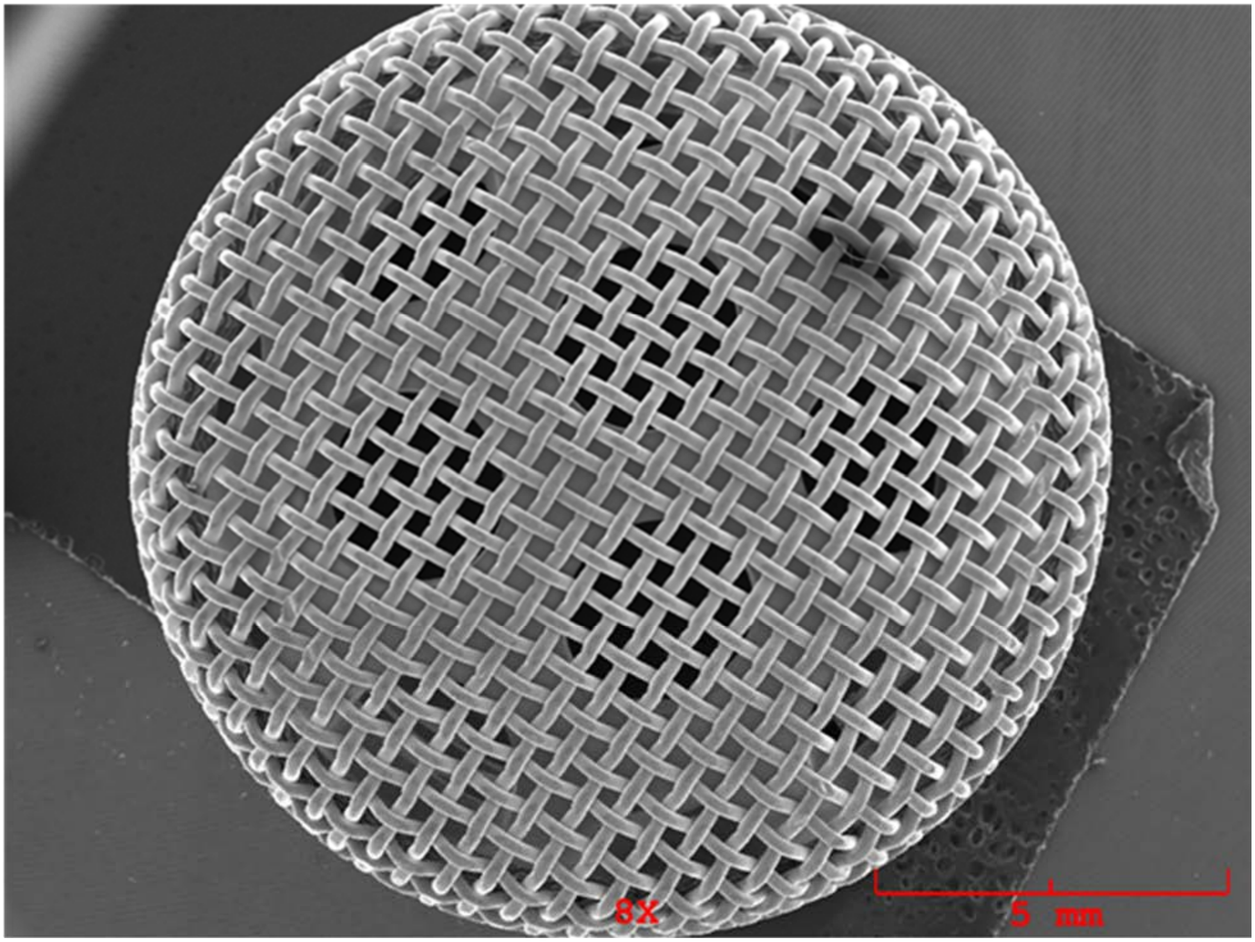
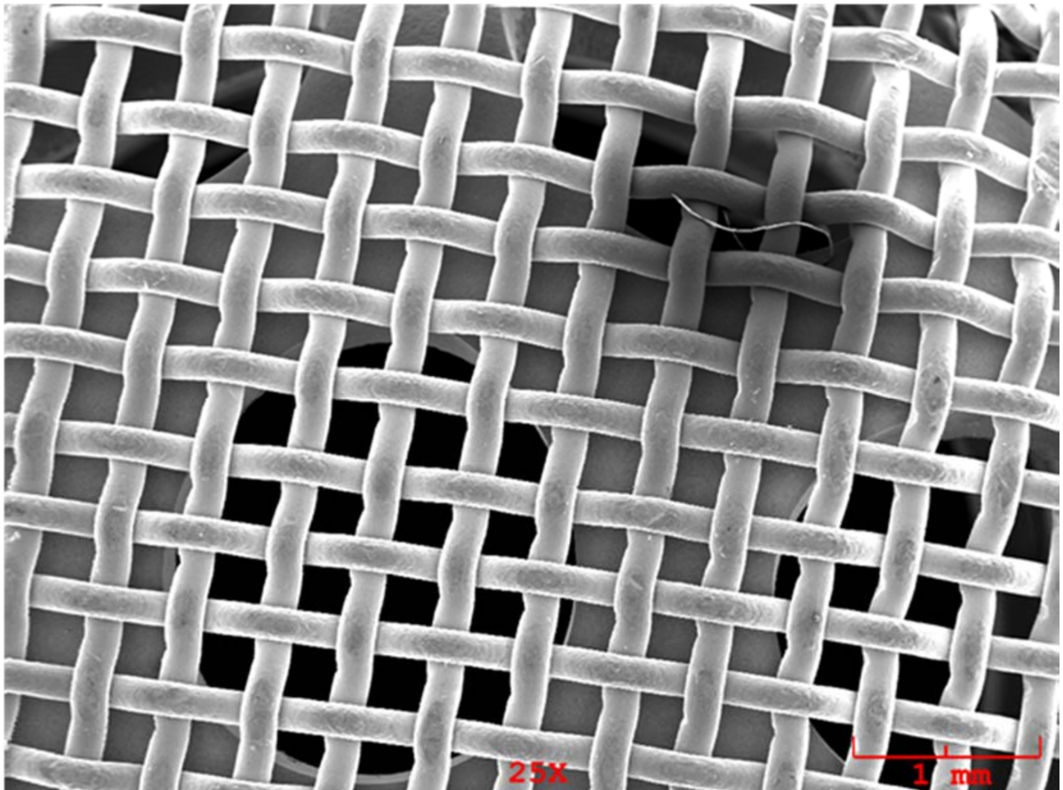


Figure N - 20 F304 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	3.05	1.649	wt.%	0.382	0.508	
S	Ka	11.56	0.989	wt.%	0.105	0.135	
Cr	Ka	136.26	15.941	wt.%	0.298	0.181	
Mn	Ka	7.95	1.285	wt.%	0.194	0.262	
Fe	Ka	360.70	70.270	wt.%	0.767	0.307	
Ni	Ka	33.68	9.865	wt.%	0.424	0.389	
			100.000	wt.%			Total

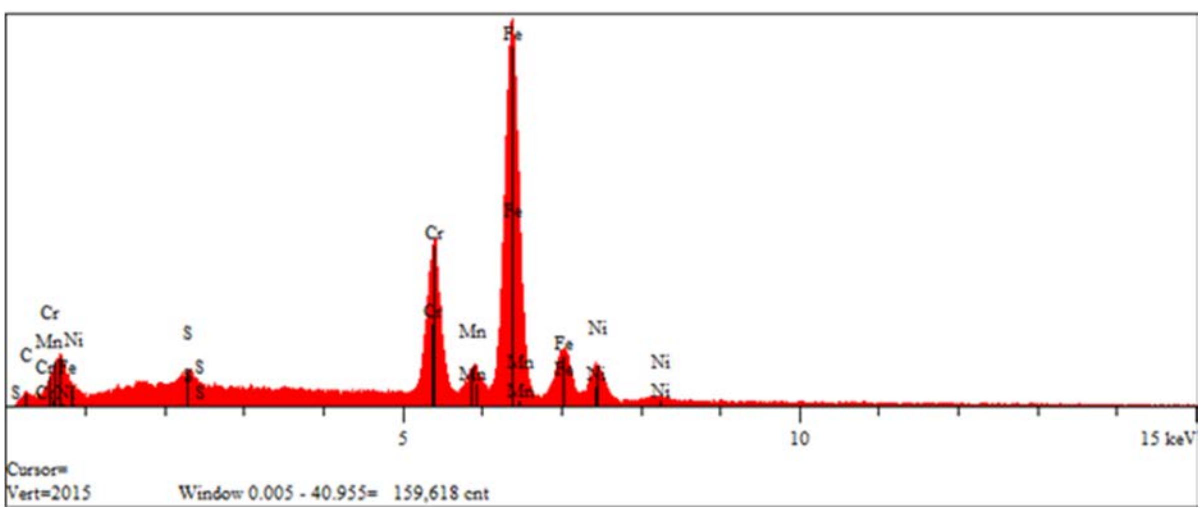


Figure N - 21 F304 Bottom, 25X and EDX Elemental Analysis

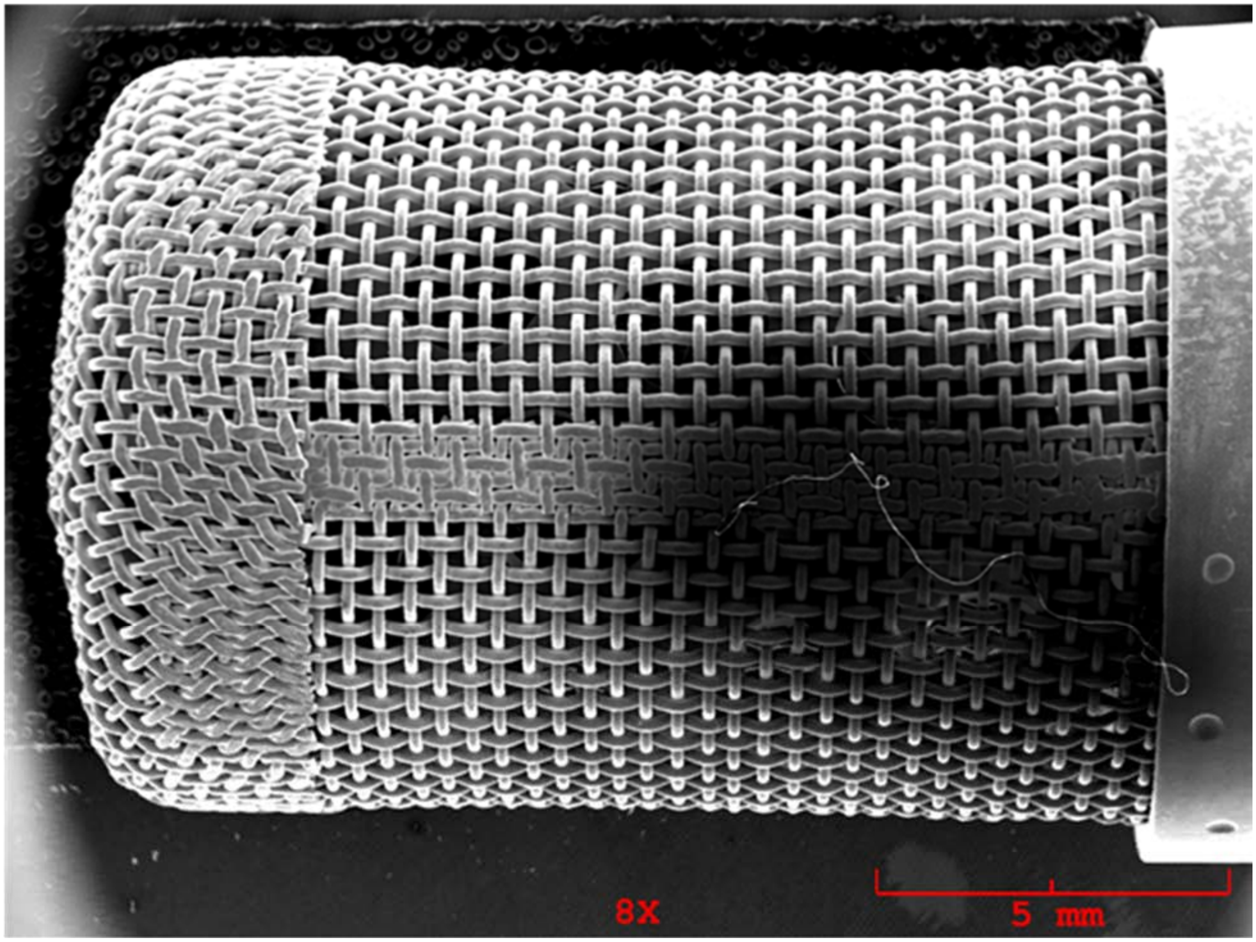
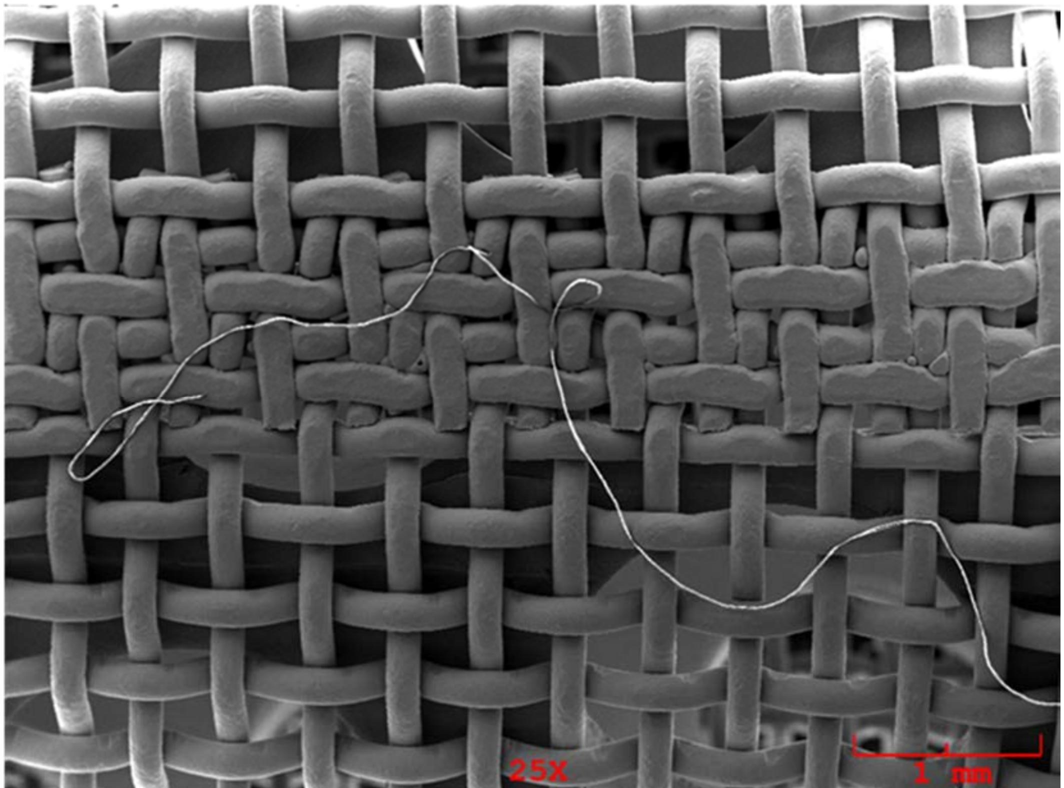


Figure N - 22 F304 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	1.91	1.139	wt.%	0.413	0.579	
Si	Ka	4.08	0.485	wt.%	0.119	0.166	
S	Ka	11.36	1.058	wt.%	0.112	0.142	
Cr	Ka	128.74	16.462	wt.%	0.316	0.191	
Mn	Ka	7.54	1.325	wt.%	0.204	0.275	
Fe	Ka	328.76	69.631	wt.%	0.797	0.325	
Ni	Ka	31.13	9.899	wt.%	0.449	0.422	
			100.000	wt.%			Total

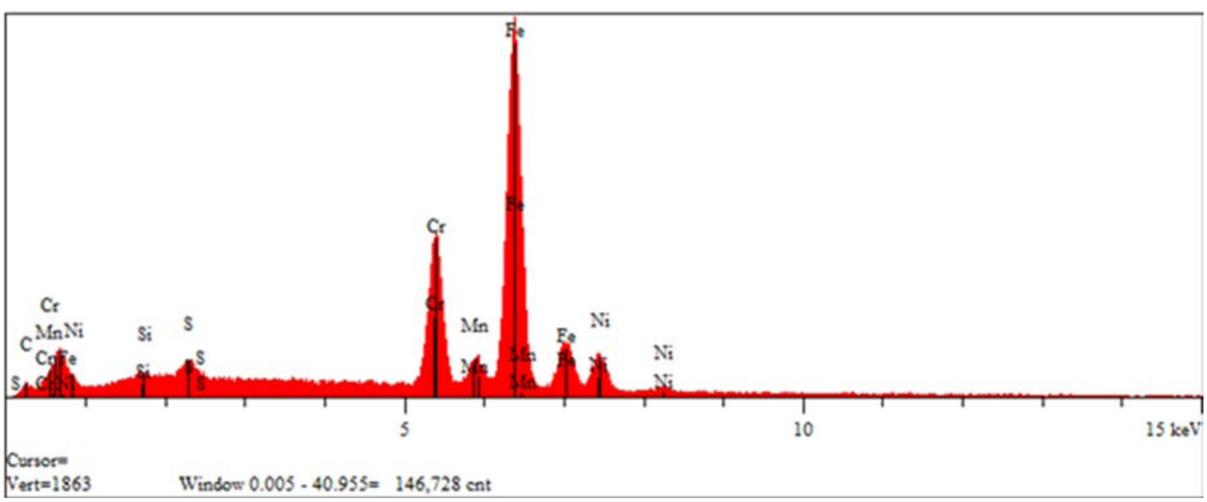


Figure N - 23 F304 Side, 25X and EDX Elemental Analysis

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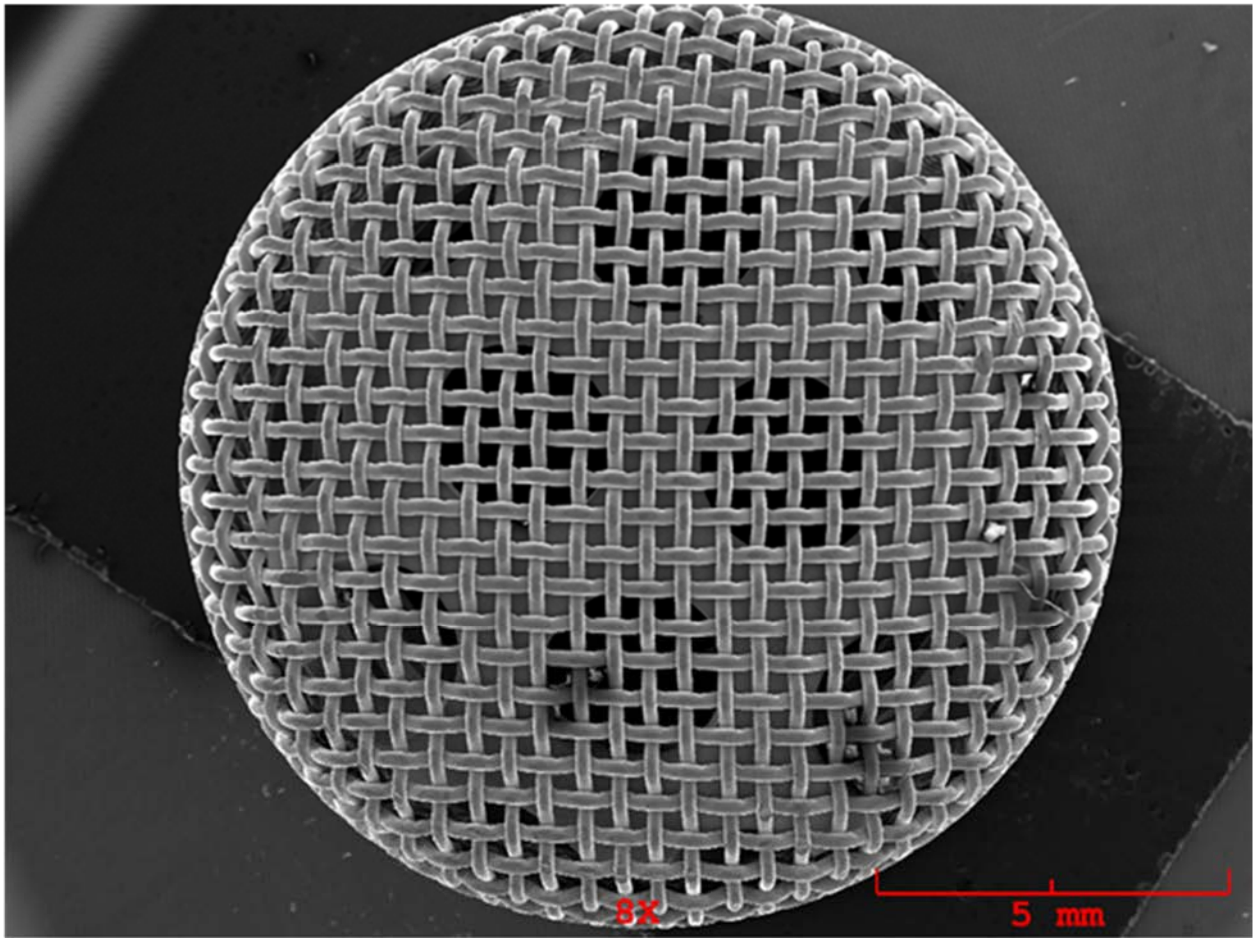
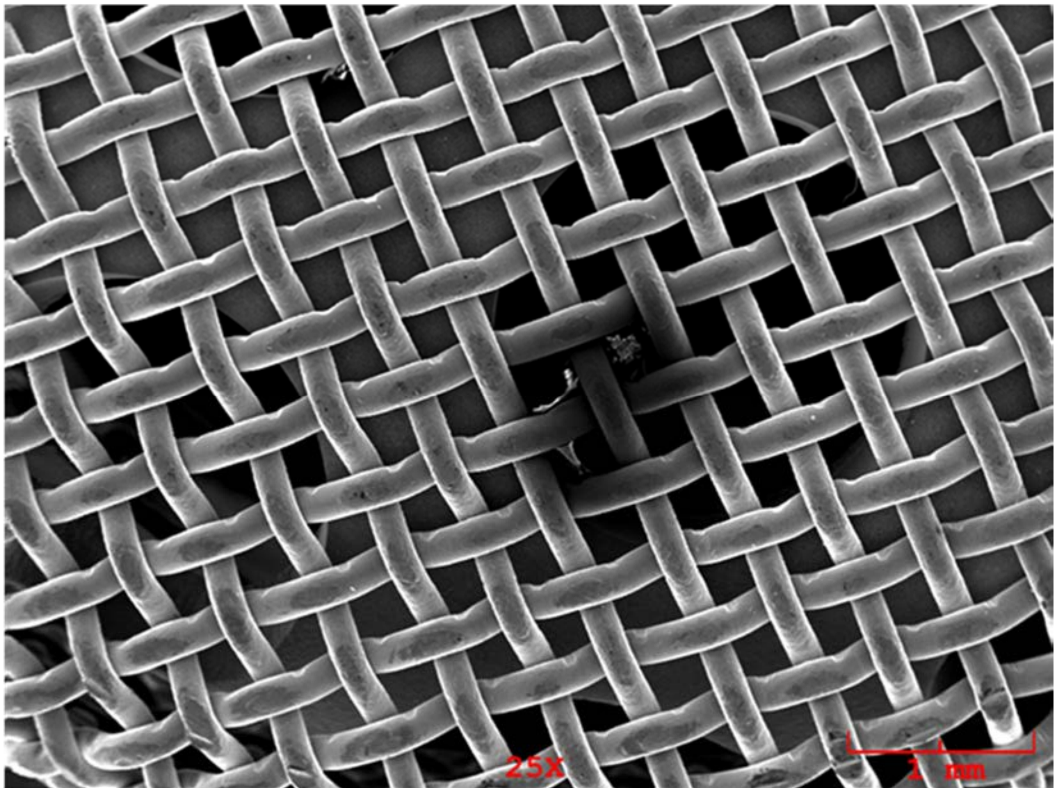


Figure N - 24 F702 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	2.38	1.507	wt.%	0.404	0.540	
Al	Ka	1.51	0.237	wt.%	0.131	0.192	
Si	Ka	4.07	0.512	wt.%	0.119	0.165	
S	Ka	11.37	1.121	wt.%	0.112	0.138	
Cr	Ka	115.65	15.604	wt.%	0.315	0.188	
Mn	Ka	8.18	1.522	wt.%	0.203	0.264	
Fe	Ka	311.35	69.731	wt.%	0.816	0.308	
Ni	Ka	29.02	9.767	wt.%	0.448	0.402	
			100.000	wt.%			Total

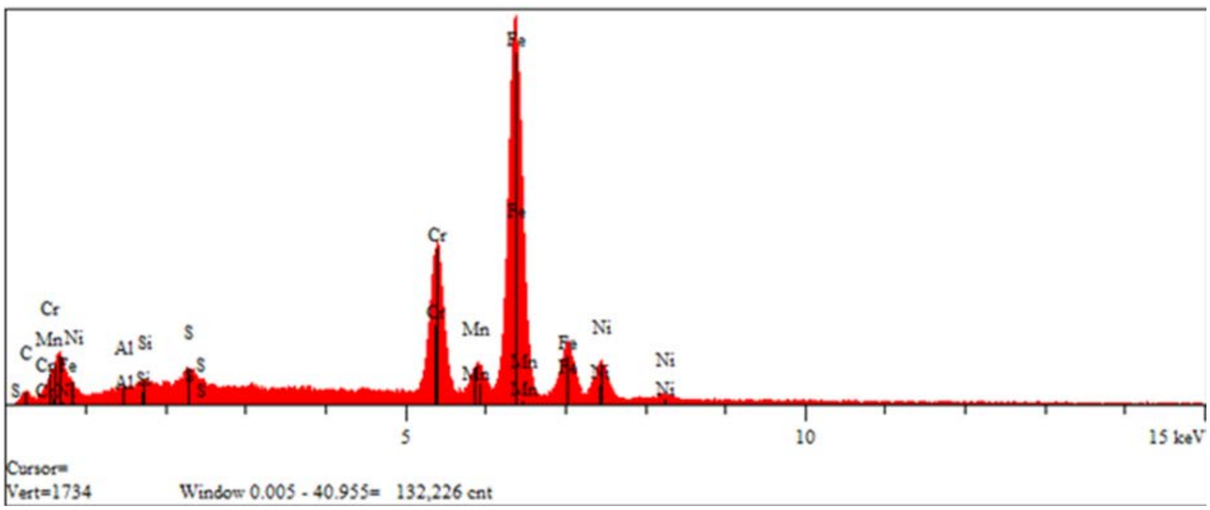


Figure N - 25 F702 Bottom, 25X and EDX Elemental Analysis

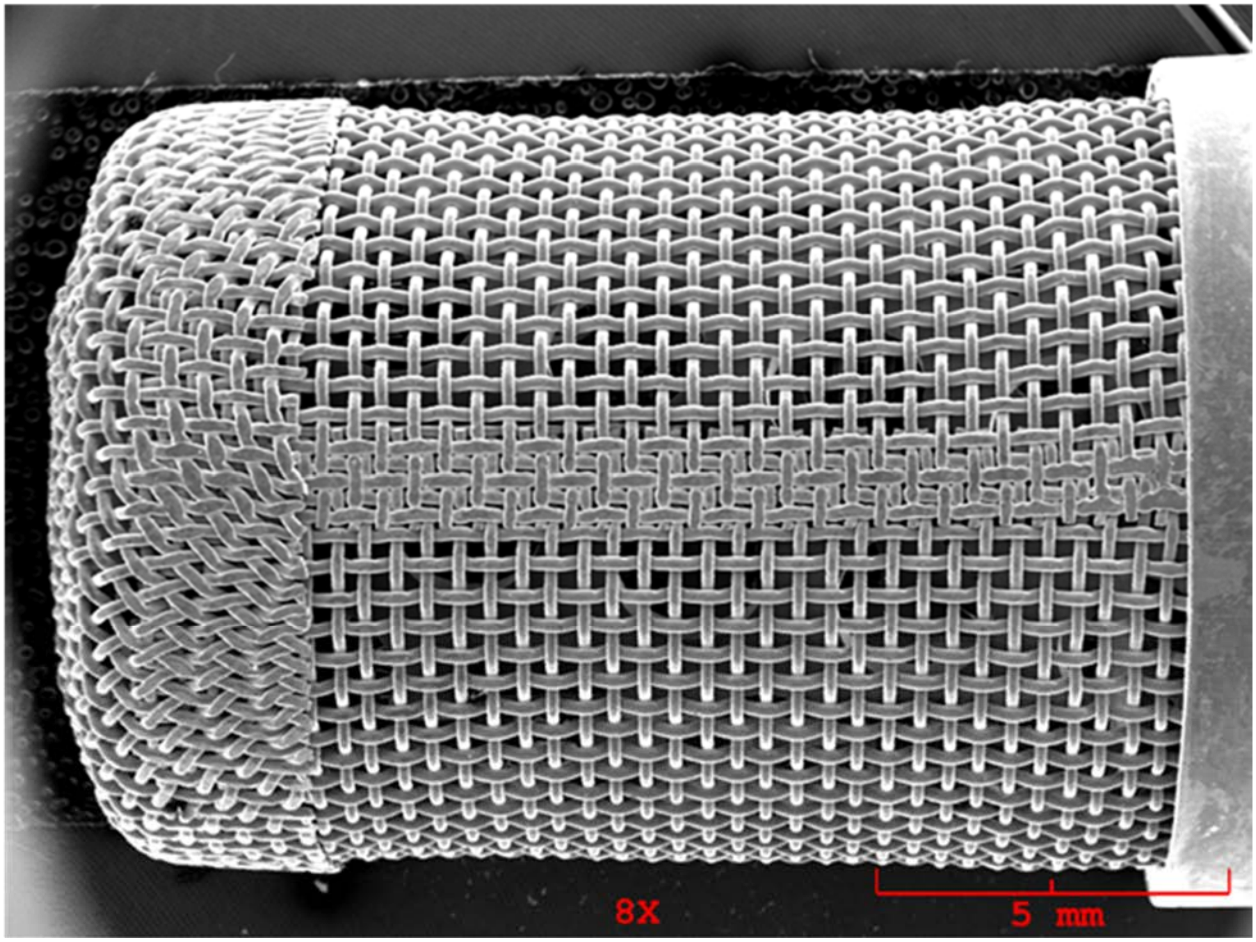
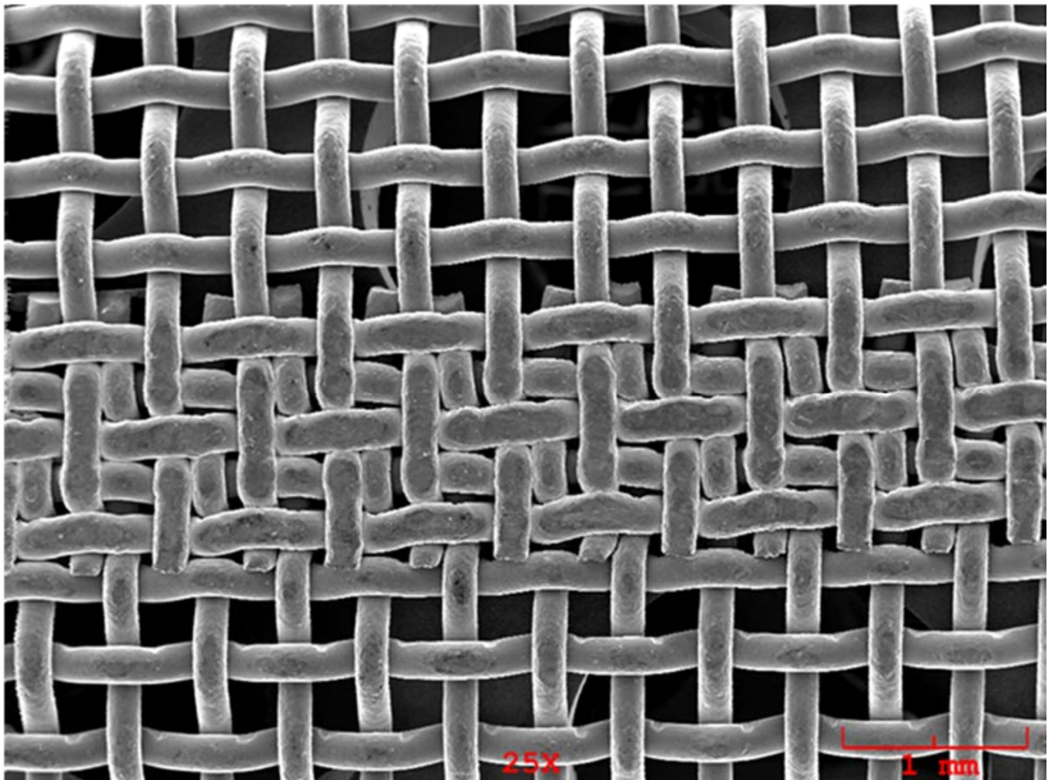


Figure N - 26 F702 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	1.70	0.998	wt.%	0.387	0.545	
Si	Ka	3.91	0.454	wt.%	0.113	0.157	
S	Ka	13.39	1.219	wt.%	0.111	0.135	
Cr	Ka	127.47	15.855	wt.%	0.306	0.185	
Mn	Ka	8.19	1.406	wt.%	0.197	0.261	
Fe	Ka	341.25	70.605	wt.%	0.790	0.306	
Ni	Ka	30.43	9.463	wt.%	0.432	0.401	
			100.000	wt.%			Total

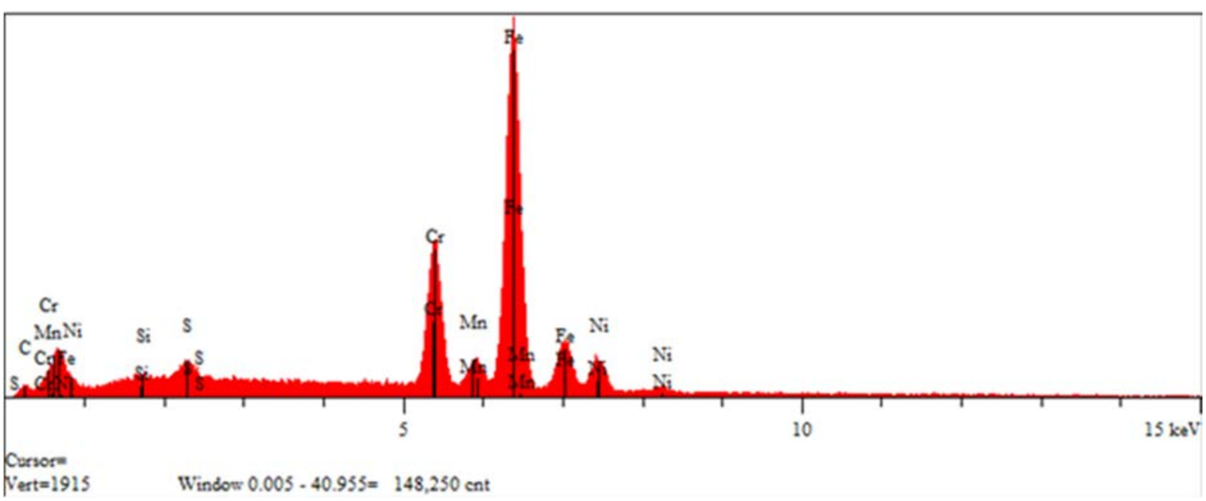


Figure N -27 F702 Side, 25X and EDX Elemental Analysis

APPENDIX O - RUN 161 DATA PACKAGE

Run Conditions: EDTST Mode, HT Conditions
Fuel ID: POSF-12831, Gulf Coast Jet A
Airframe Heat Exchanger Bulk Fuel Output: 285 °F
HP Pump HX Out/FCOC Bulk Fuel In: 350 °F
Fuel-Cooled Oil Cooler Bulk Fuel Output: 375 °F
Burner Feed Arm Max Wetted Wall Temperature: 510 °F
Run Duration: 63 Hours Terminated due to HP Pump failure

Component/Device

Run 161; Run Type: EDTST; Op Mode: HT; MSNs: N/A; EDTST Run Hours: 63* Fuel ID#: POSF12831; Run Tank: S-15; Run Type: EDTST; Op Mode: HT Fuel Type: Jet-A; Additive(s): None AFHX Out: 285 °F; FCOC In: 325 °F; FCOC Out: 375 °F; BFA MWWT: 510 °F;

Component/Device	Serial No.	Pre-Test %	Post-Test %	Spread (Pre/Post Delta), %	Shift, PPH	Skew, PSID	Flow Range Shift, PPH	Flow Midpoint Shift, PPH	Overall Rating	
FDV	1268	2.1	13.6	11.5	-1.9	0.9	0.6	0.3	Severe	
Servo2	019	10.7	20.3	9.6	0.5	-0.1	0.0	0.0	Moderate	
Effective Carbon - µgrams										
Component/Device	**Section 1**	**Section 2**	**Section 3**	**Section 4**	**Section 5**	**Section 6**	**Section 7**	**Section 8**	**Section 9**	**Section 10**
FCOC Witness Tube	165.7	195.6	138.2	70.2	82.9					
BFA	174.6	274.4	387.8	616.4	678.3	819.3	934.5	899.3	822.7	671.2
Total FCOC Carbon, µgrams	652.6	µgrams	0.7	mgrams						
Total BFA Carbon, µgrams	6278.4	µgrams	6.3	mgrams						
SCREENS	Total Carbon, µg	Background Carbon, µg	Effective Carbon, µg	MWWT Start	MWWT End	Delta BFA MWWT	BFA AWWT Start	BFA AWWT End	Delta BFA AWWT	
TMS	34.1	0.3	33.7	507.91	68.76	-439.15	490.33	491.77	1.44	
F303	191.2	25.4	165.8							
F304	187.8	12.9	174.9							
F702	2035.6	12.9	2022.7							
Effective Carbon Deposition - µgrams/cm^2										
Component/Device	**Section 1**	**Section 2**	**Section 3**	**Section 4**	**Section 5**	**Section 6**	**Section 7**	**Section 8**	**Section 9**	**Section 10**
FCOC Witness Tube	45.4	53.6	37.9	19.2	22.7					
BFA	101.3	159.3	225.1	357.8	393.7	475.6	542.4	522.0	477.5	389.6
TMS Mass Change - grams										
Component/Device	**Tare, g**	**Mass, g**	**Mass Gain, g**							
TMS	0.08613	0.08619	6E-05							
F303	7.11861	7.11896	0.00035							
F304	3.06694	3.06757	0.00063							
F702	3.05	3.04928	0.00393							

Hysteresis Ratings:

- NONE: indicating that the pre-test and post-test hysteresis curves, for all intents and purposes, are nearly indistinguishable from one another. Minor differences may be seen between the pre-test and post-test curves but these are very small.
- Minor: There are small differences between per- and post-test curves. The spread for these curves is typically within 5% of one another. There may be some small changes in shift and skew for the valve. This degree of hysteresis would not be expected to alter the functional nature of the valve.
- Moderate: There are definite differences between pre-and post-test curves. There may be definite differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically between 5% and 15%. This degree of hysteresis might be expected to alter the functional nature of the valve.
- Severe: There are pronounce differences between pre-and post-test curves. There may be pronounced differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically in excess 15%. This degree of hysteresis would be considered out-of-spec for the valve.
- Non-Functional: There are major differences between pre-and post-test curves. There may be major differences in shift and skew as well. The hysteresis curve will exhibit flat segments (either vertically or horizontally). Shift and skew have majorly changed the performance envelope of the valve. This degree of hysteresis would cause the valve to be non-functional or unresponsive over small or large portions of the performance range of the valve.

Figure O - 1 Run 157 Data Summary

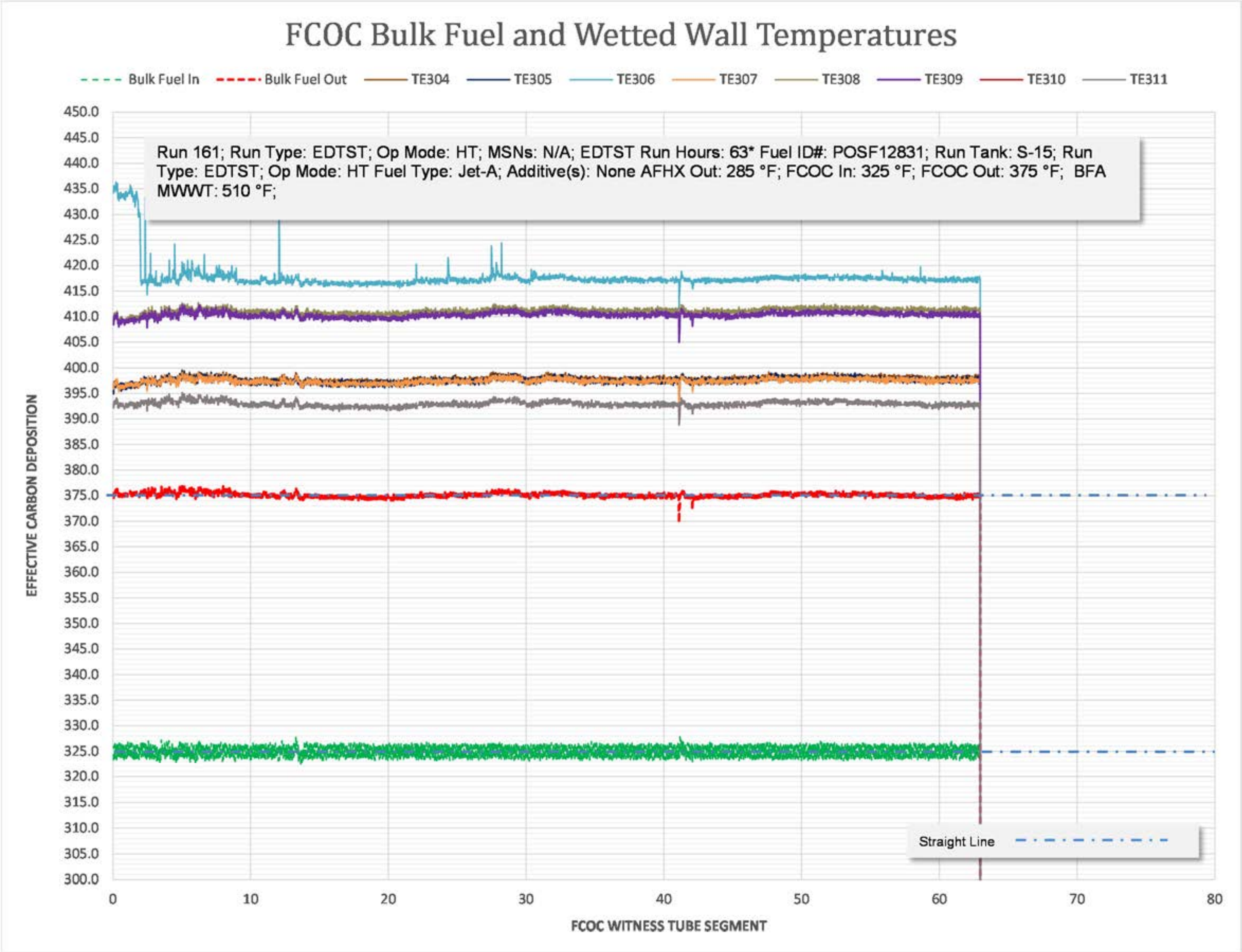


Figure O - 2 FCOC Bulk Fuel and Wetted Wall Temperatures

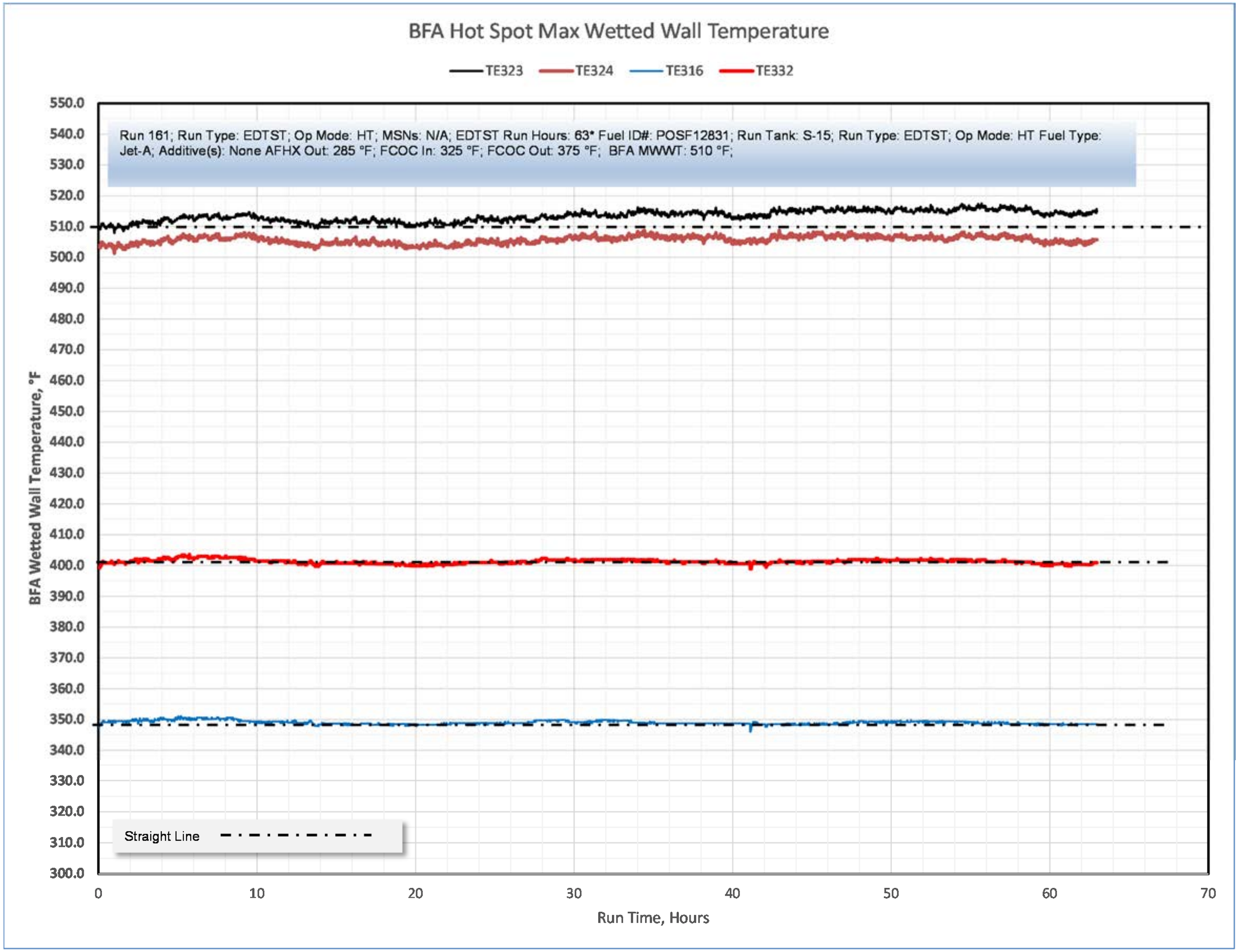
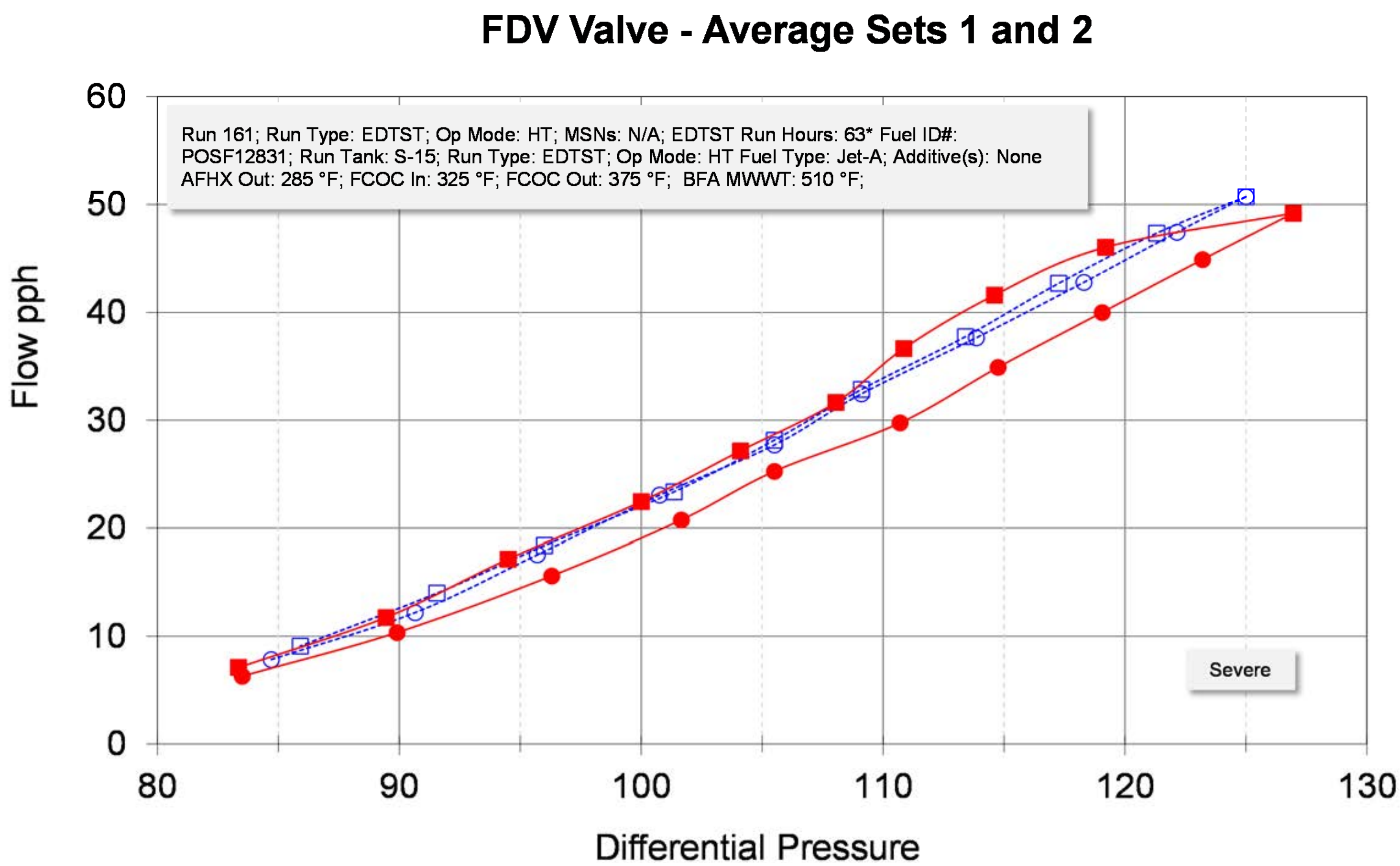


Figure O - 3 BFA Hot Spot Max Wetted Wall And Bulk Fuel Temperatures



Pre-Test Hysteresis at 135.0 PSID = 2.09 %

Pre/Post-Test Hysteresis at 135.0 PSID = 11.53 %

Pre/Post-Test Hysteresis Shift = -1.91 PPH

Post-Test Hysteresis at 135.0 PSID = 13.63 %

Pre/Post-Test Hysteresis Shift = -1.91 PPH

Pre/Post-Test Hysteresis Skew = .89 PSID

--○-- Post-Test Increasing —●— Post-Test Increasing --□-- Pre-Test Decreasing —■— Post-Test Decreasing

Figure O - 4 FDV Hysteresis

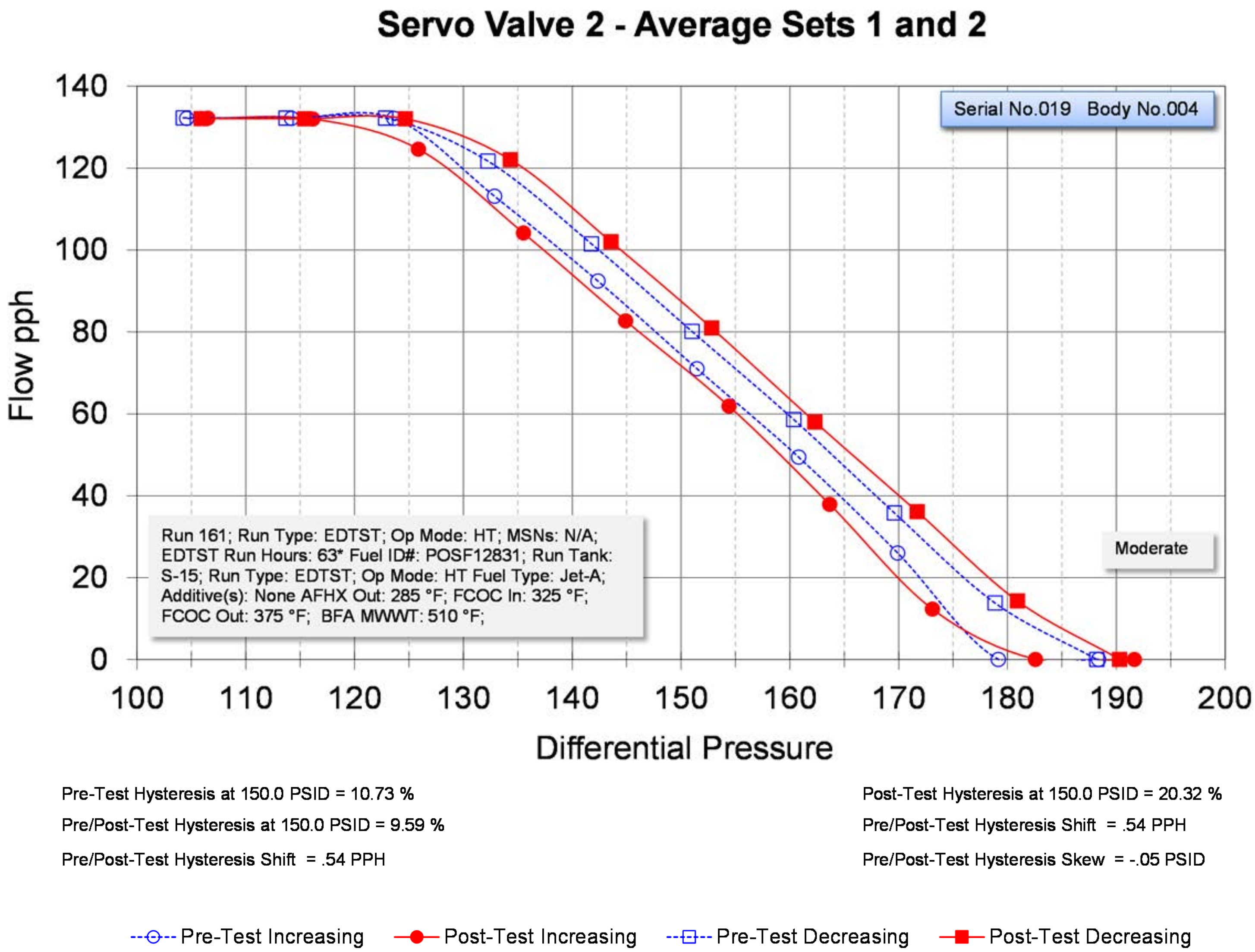


Figure O - 5 Servo Valve Hysteresis

DISTRIBUTION STATEMENT A: Approved for public release. Distribution is unlimited.

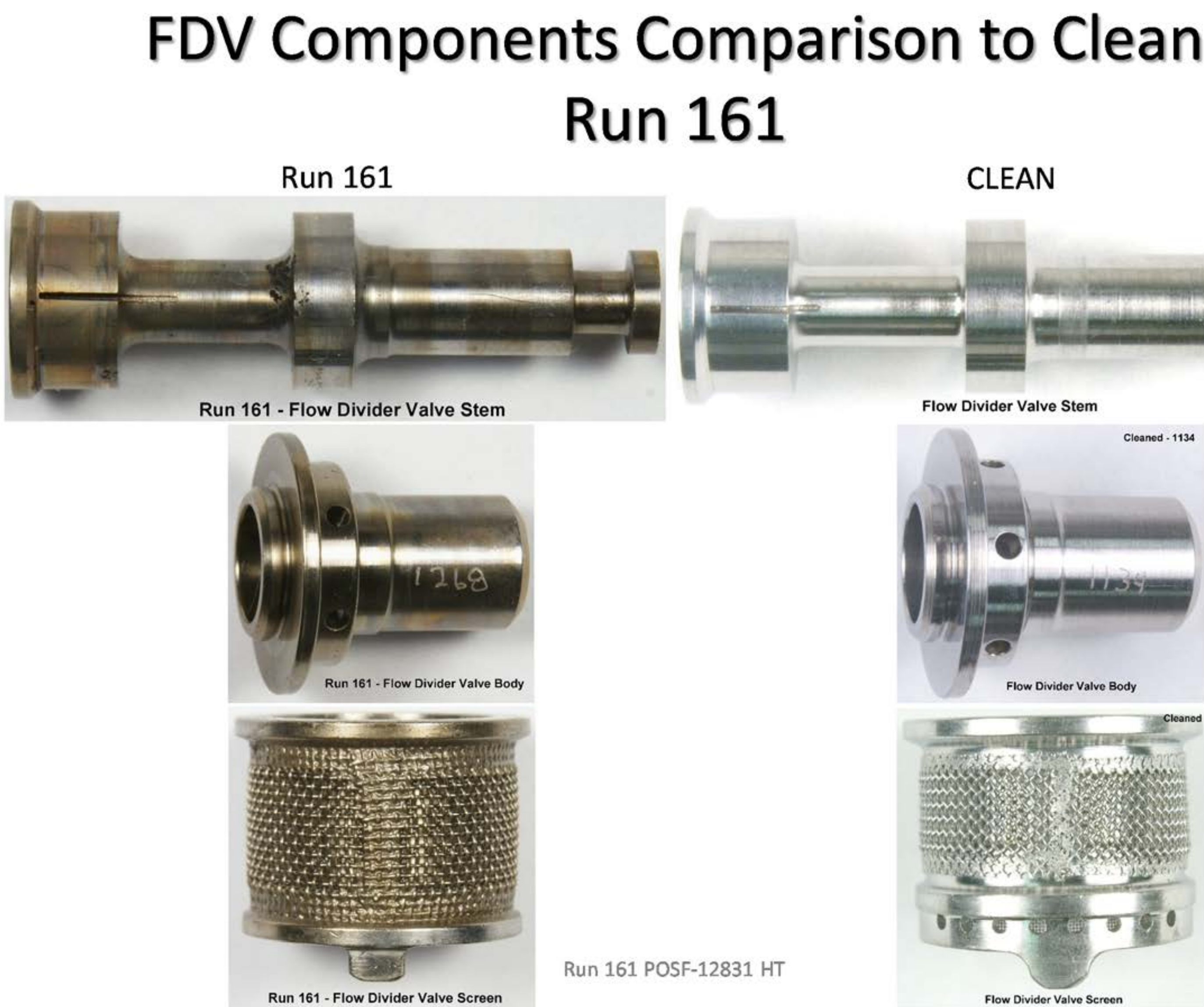


Figure O - 6 FDV Components - Comparison to Clean

Servo Valve and Nozzle Screen Simulator Components – Comparison To Clean - Run 161

Run 161 | Clean

Run 161 POSF-12831 HT

Figure O - 7 Servo Valve and Nozzle Screen Components - Comparison to Clean

TMS Screens Comparison to Clean - Run 161

Run 161

CLEAN

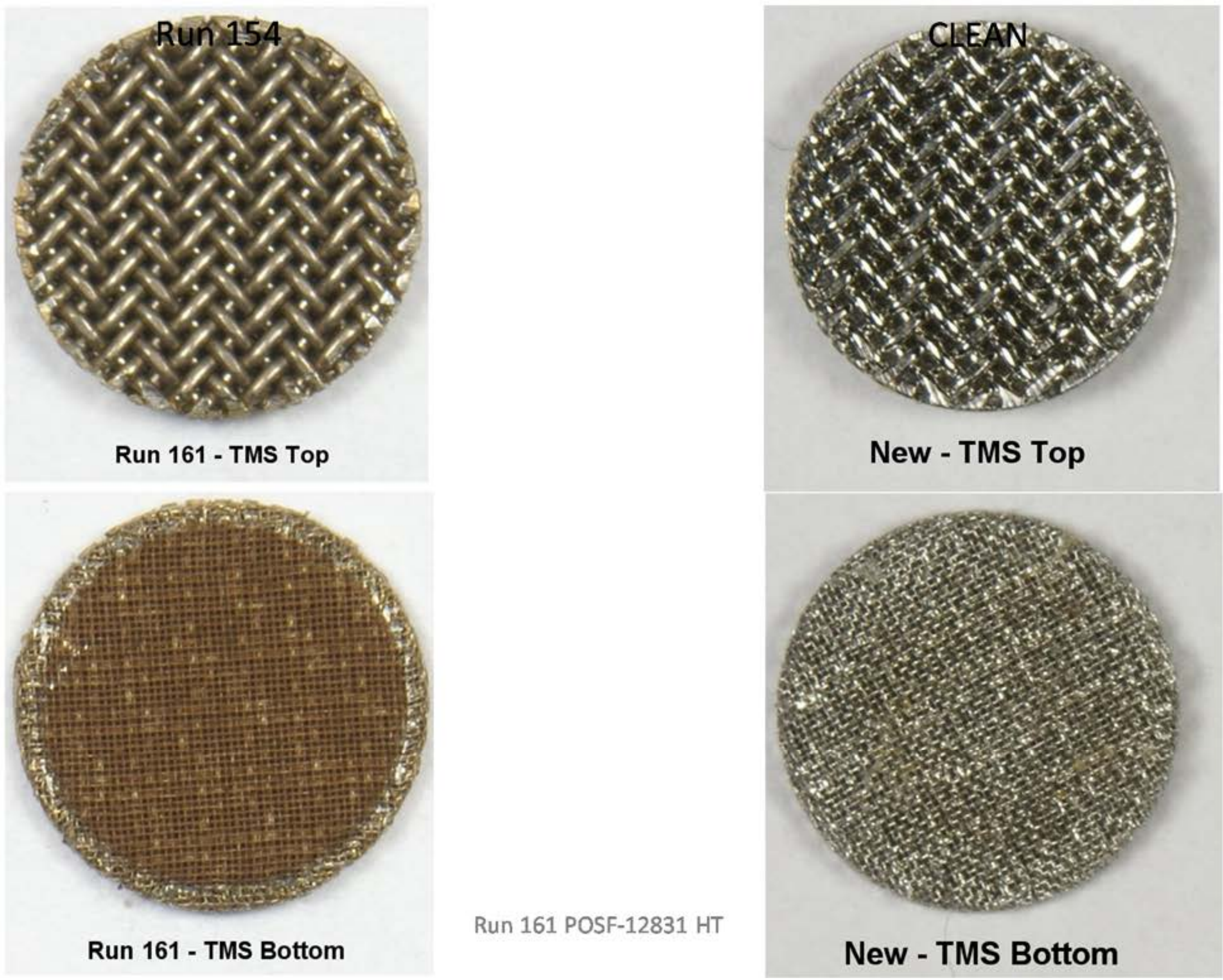


Figure O - 8 TMS Screen Top and Bottom - Comparison to Clean

GCxGC Results

N/A

Figure O - 9 GCxGC Summary POSF-12831 BFA Outlet

Table O - 1 GCxGC Tabulated Data POSF-12831 Jet A Neat and Run 151 BFA Outlet

N/A

N/A

Figure O - 10 GCxGC Summary Fuel From Body Tank

Table O - 2 GCxGC Tabulated Data - Fuel From Body Tank at the End Of Run

N/A

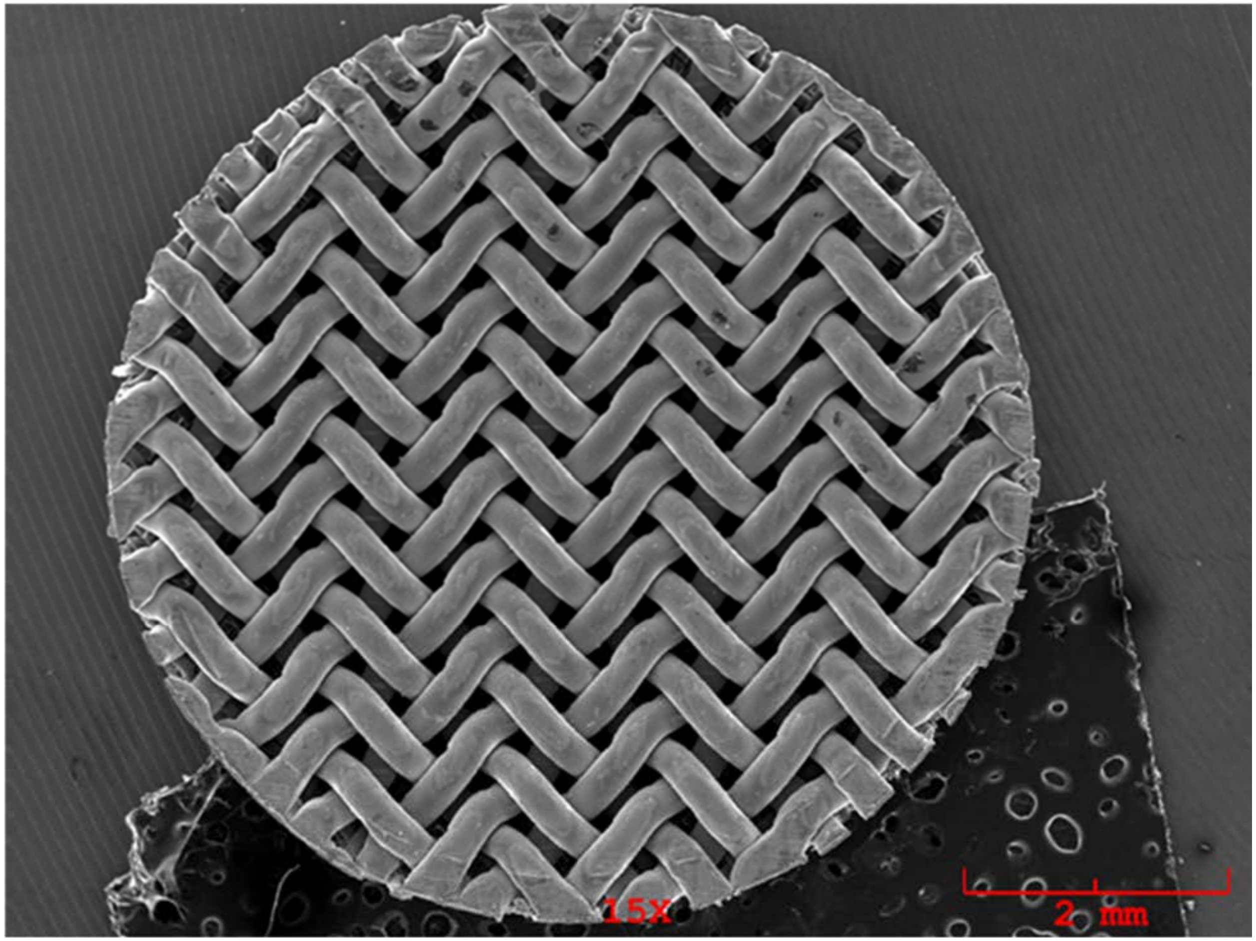
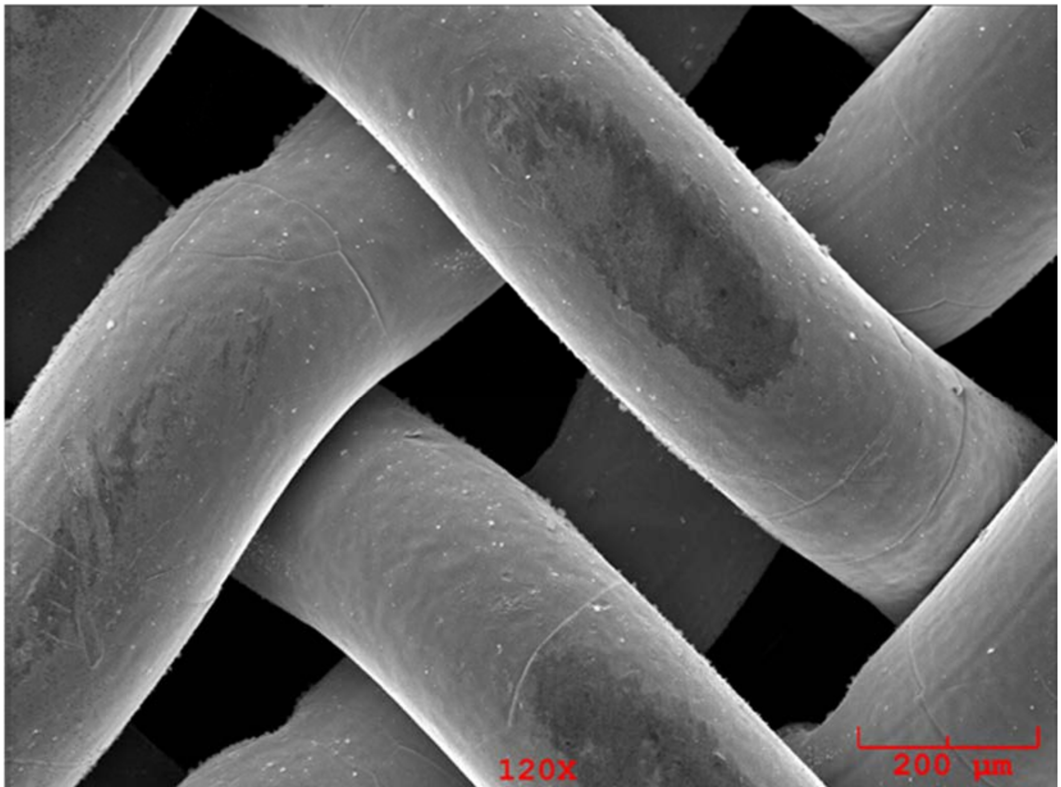


Figure O - 11 TMS Screen, Top, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	7.46	3.456	wt.%	0.395	0.465	
S	Ka	11.83	0.882	wt.%	0.097	0.126	
Cr	Ka	162.68	16.858	wt.%	0.288	0.175	
Mn	Ka	9.72	1.382	wt.%	0.186	0.250	
Fe	Ka	399.42	68.531	wt.%	0.710	0.284	
Ni	Ka	34.60	8.891	wt.%	0.387	0.370	
			100.000	wt.%			Total

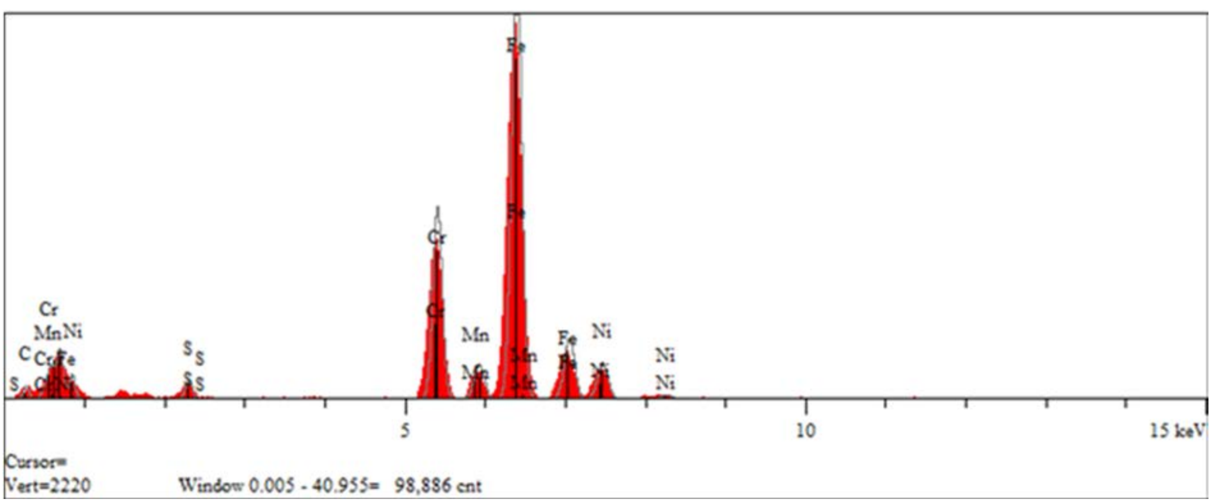


Figure O - 12 TMS Screen Top, 120X and EDX Elemental Analysis

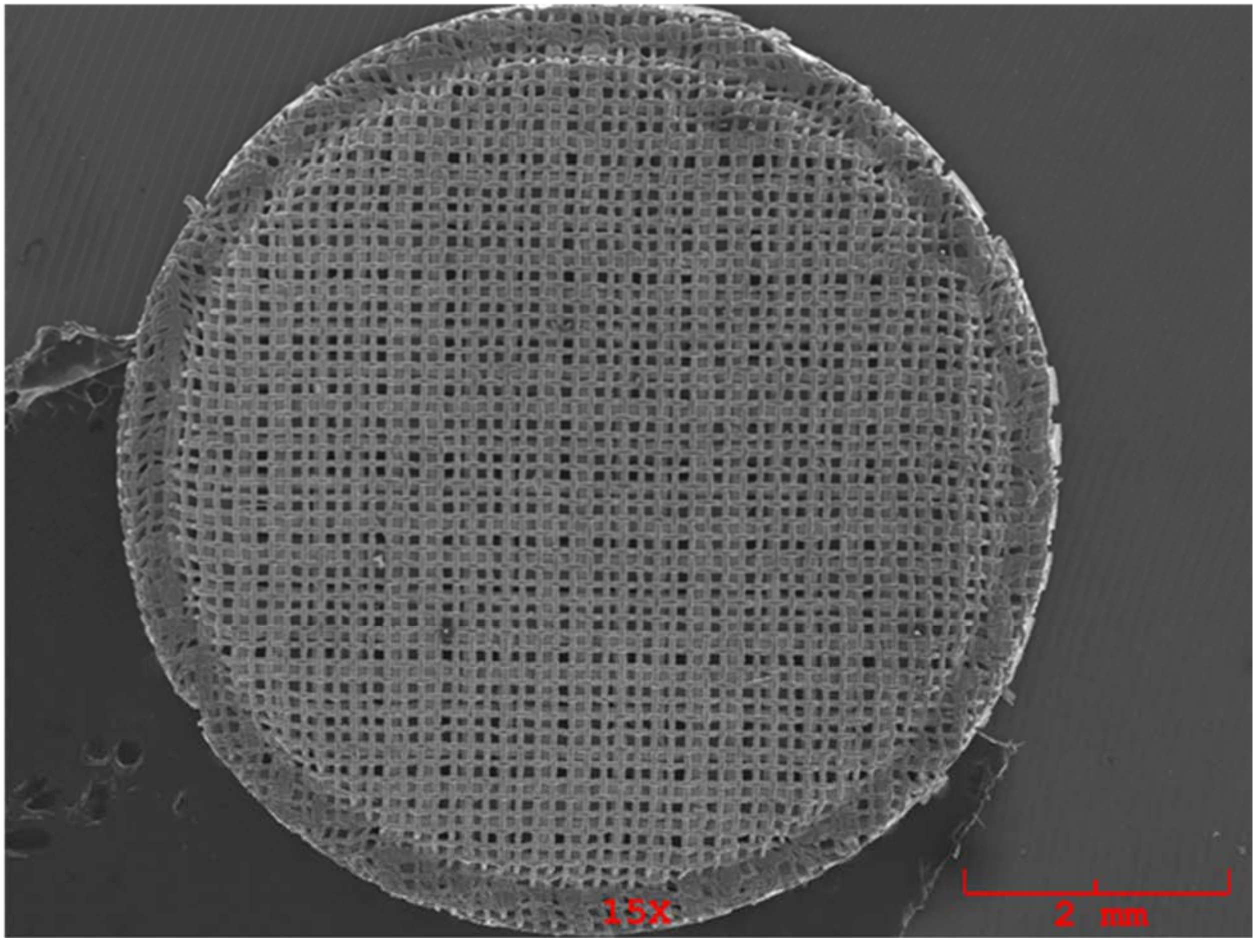
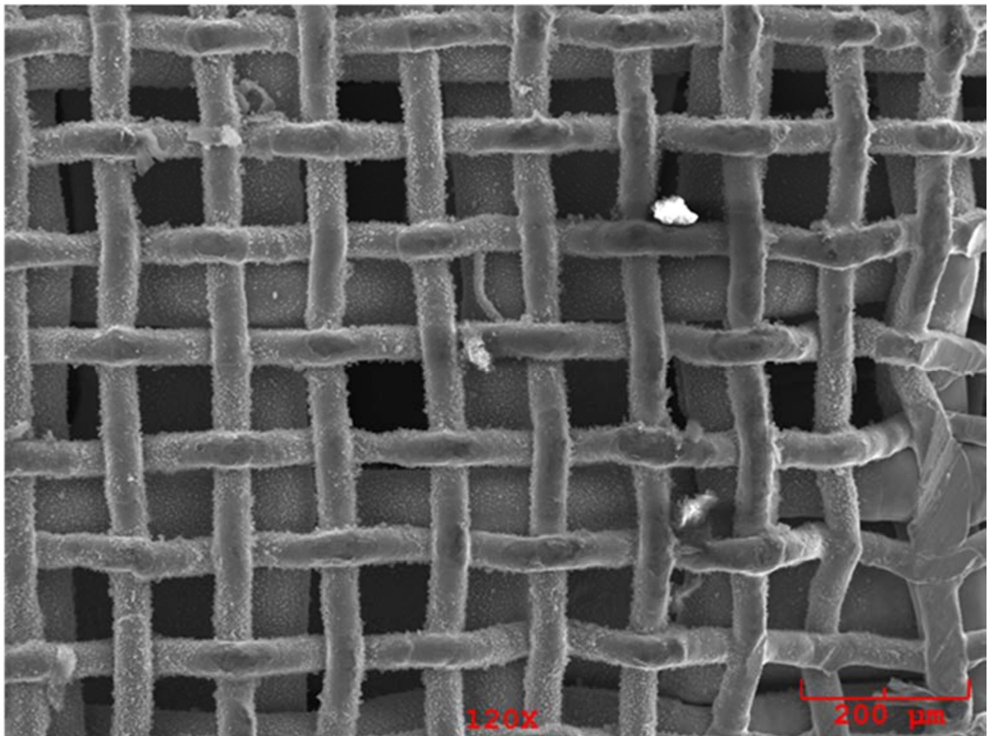


Figure O - 13 TMS Screen, Bottom, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	10.21	8.735	wt.%	0.853	1.003	
O	Ka	2.94	1.012	wt.%	0.258	0.351	
Al	Ka	5.88	1.192	wt.%	0.192	0.253	
S	Ka	19.16	2.507	wt.%	0.167	0.186	
Cr	Ka	85.63	16.169	wt.%	0.394	0.279	
Mn	Ka	2.46	0.628	wt.%	0.279	0.409	
Fe	Ka	196.42	60.145	wt.%	0.912	0.473	
Ni	Ka	12.72	5.772	wt.%	0.481	0.545	
Cu	Ka	6.84	3.840	wt.%	0.476	0.574	
			100.000	wt.%			Total

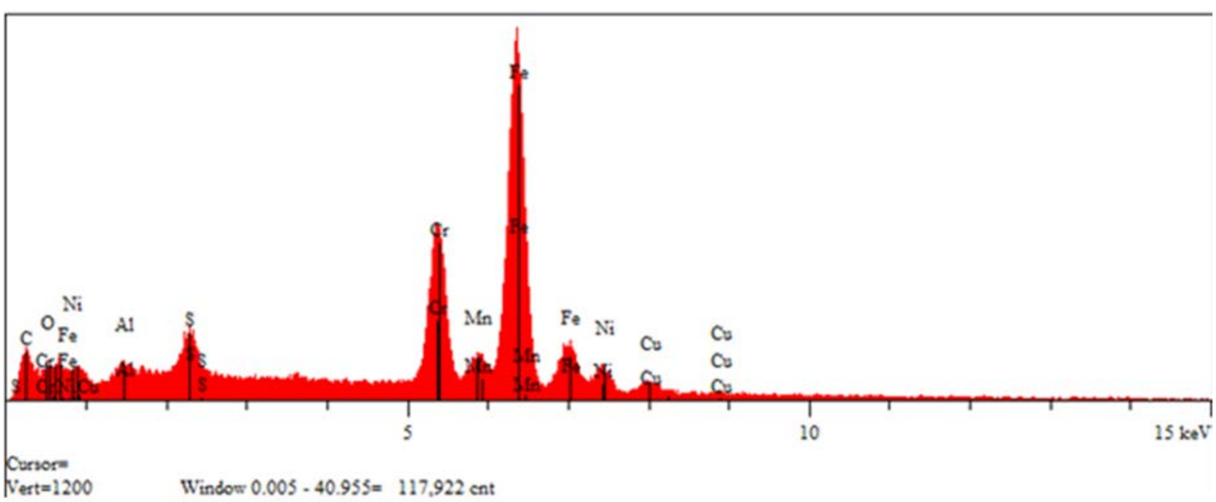


Figure O - 14 TMS Screen, Bottom, 120X and EDX Elemental Analysis

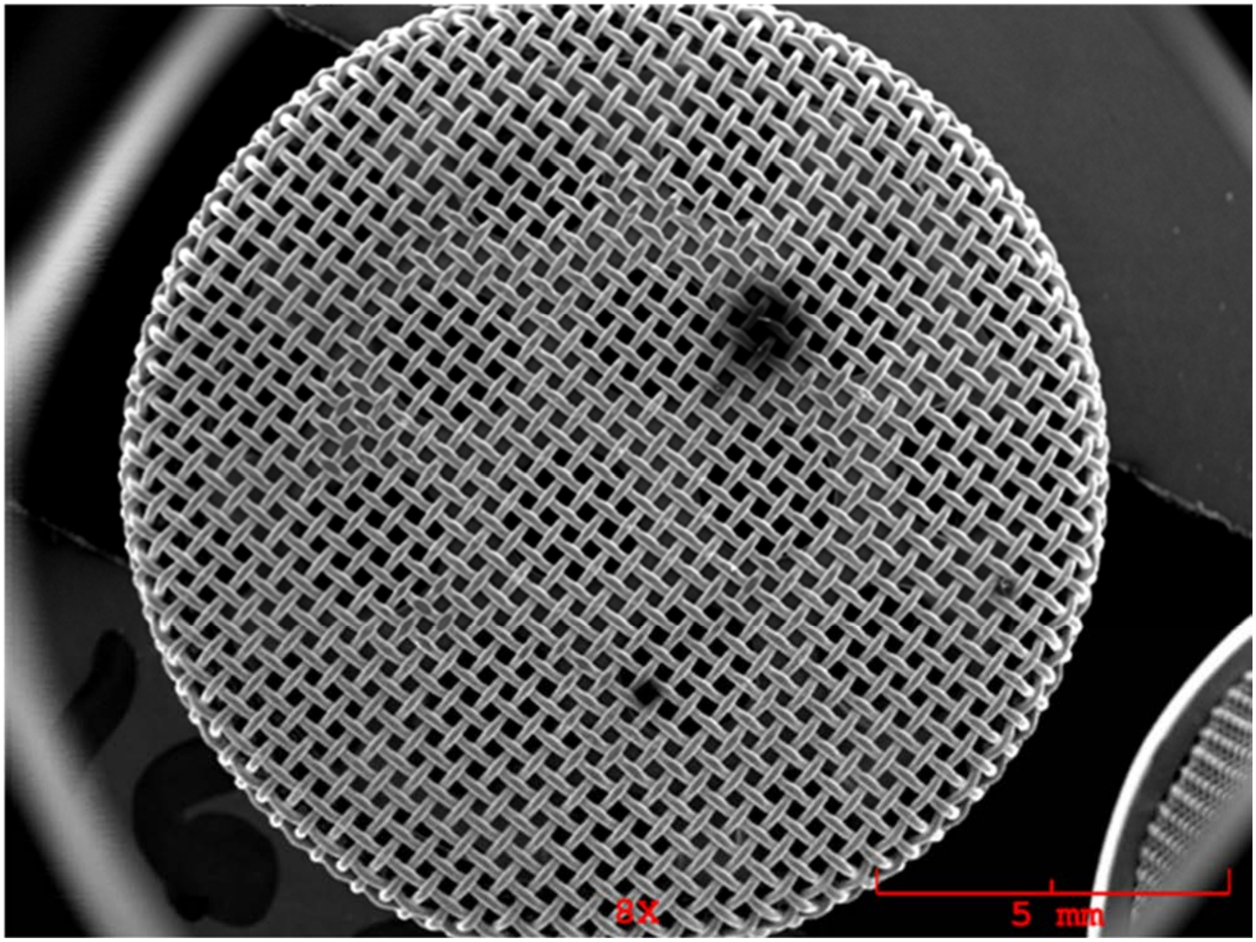
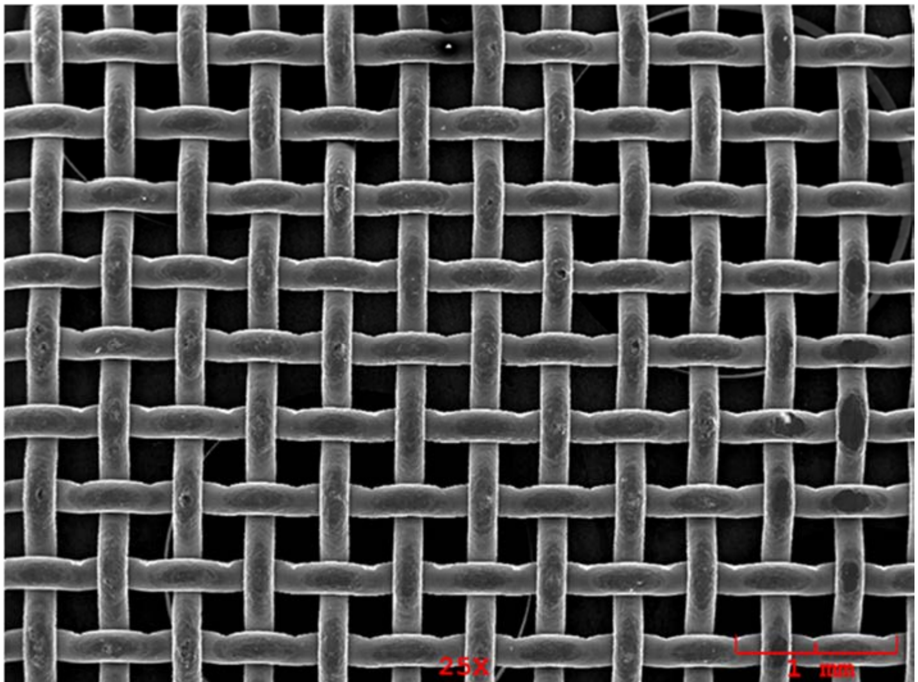


Figure O - 15 F303 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	1.01	0.651	wt.%	0.458	0.672	
Si	Ka	2.76	0.357	wt.%	0.127	0.182	
S	Ka	11.67	1.177	wt.%	0.122	0.155	
Cr	Ka	116.72	16.015	wt.%	0.327	0.210	
Mn	Ka	5.13	0.974	wt.%	0.225	0.318	
Fe	Ka	312.22	71.556	wt.%	0.847	0.380	
Ni	Ka	26.90	9.269	wt.%	0.468	0.462	
			100.000	wt.%			Total

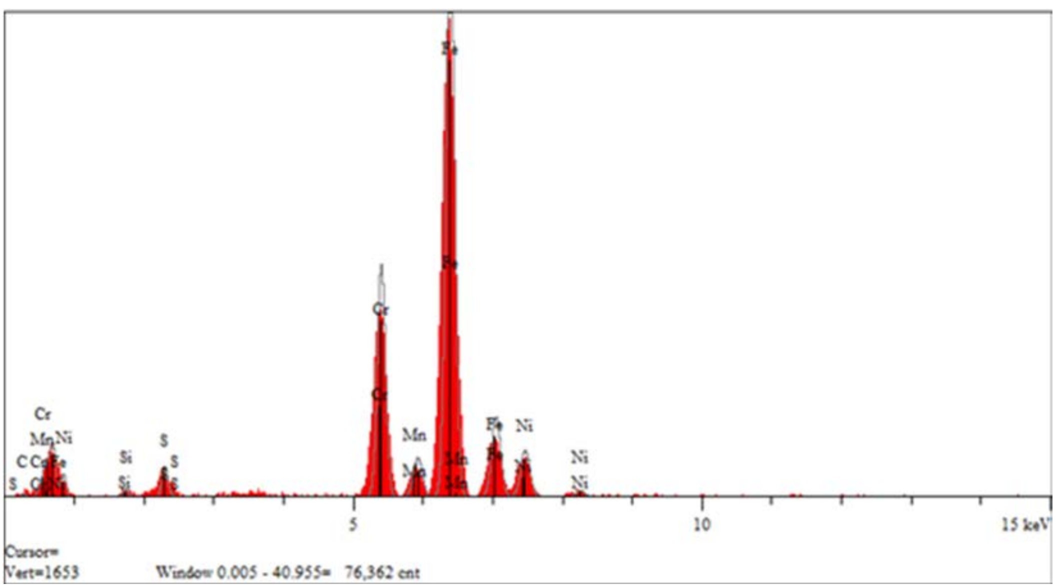


Figure O - 16 F303 Bottom 25X and EDX Elemental Analysis

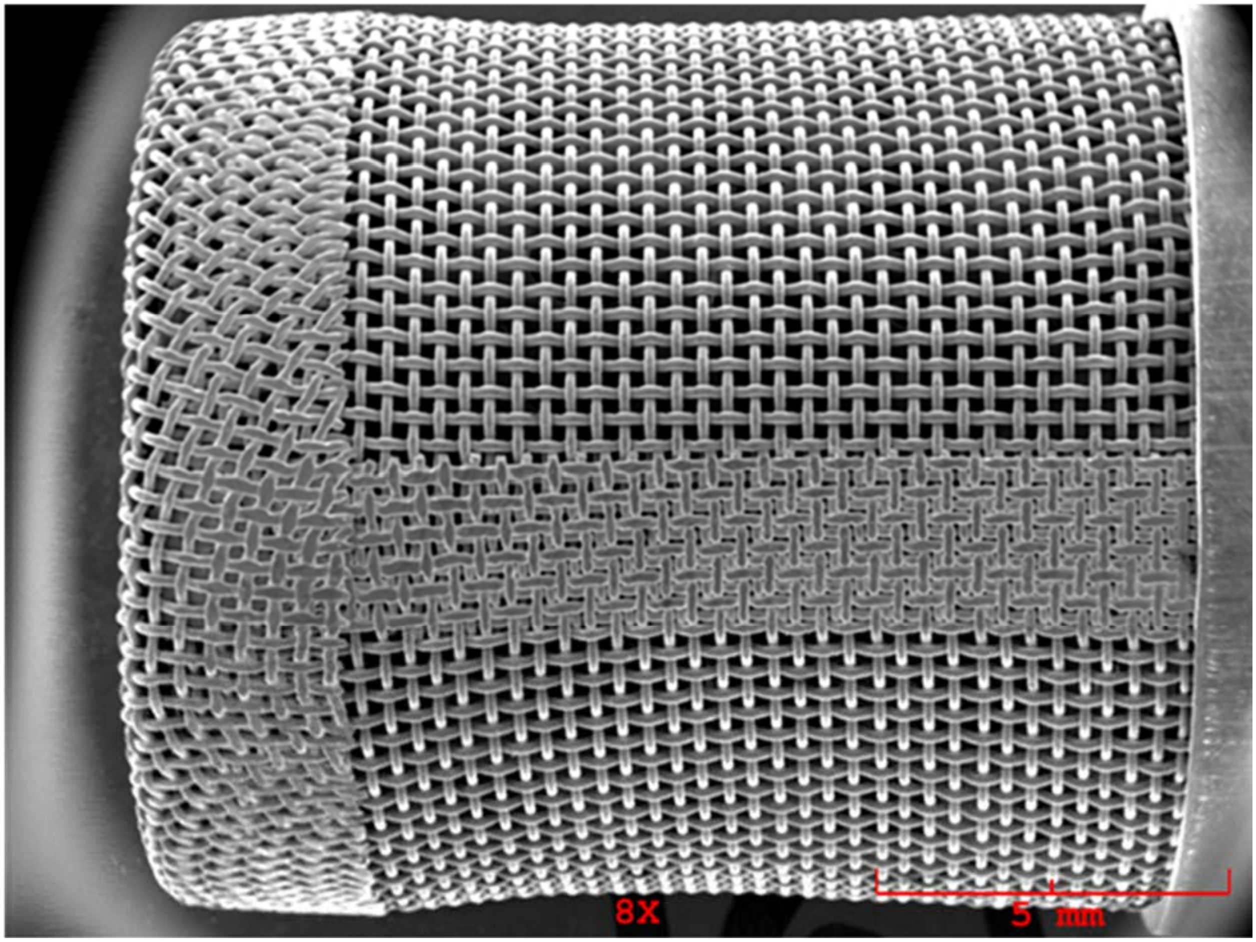
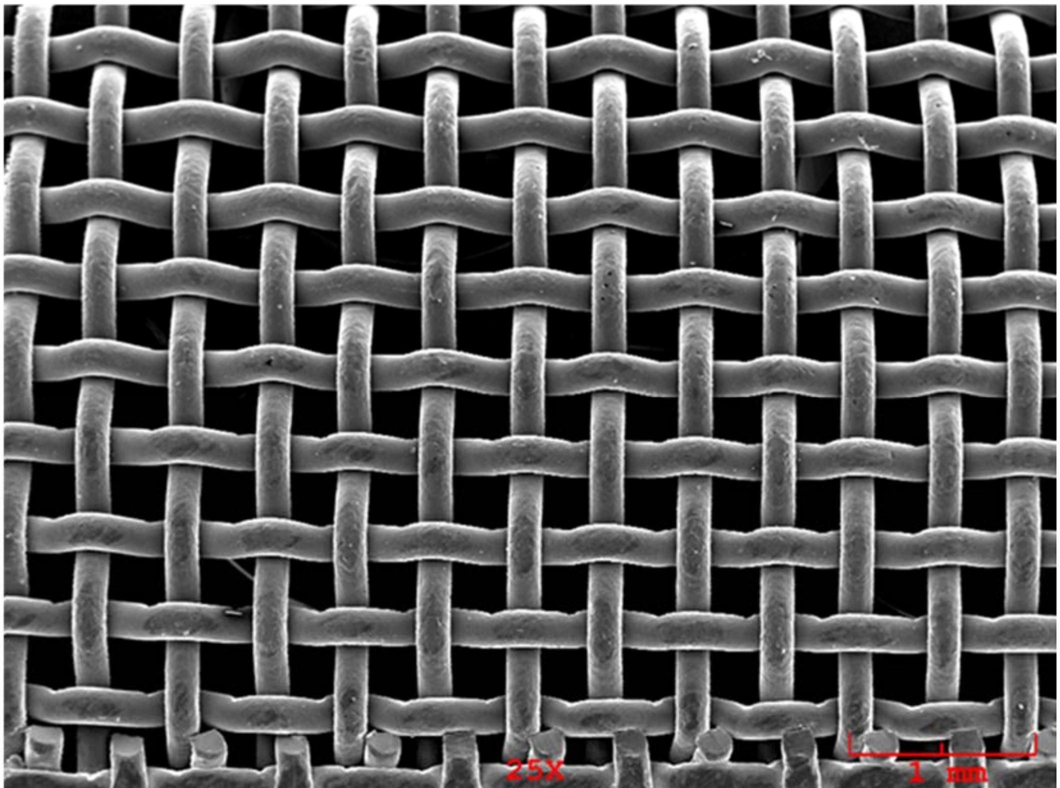


Figure O - 17 F303 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	3.47	2.027	wt.%	0.426	0.560	
Si	Ka	2.30	0.269	wt.%	0.118	0.172	
S	Ka	13.03	1.191	wt.%	0.114	0.143	
Cr	Ka	126.34	15.862	wt.%	0.310	0.197	
Mn	Ka	7.73	1.337	wt.%	0.210	0.285	
Fe	Ka	333.60	69.550	wt.%	0.792	0.335	
Ni	Ka	31.18	9.763	wt.%	0.437	0.402	
			100.000	wt.%			Total

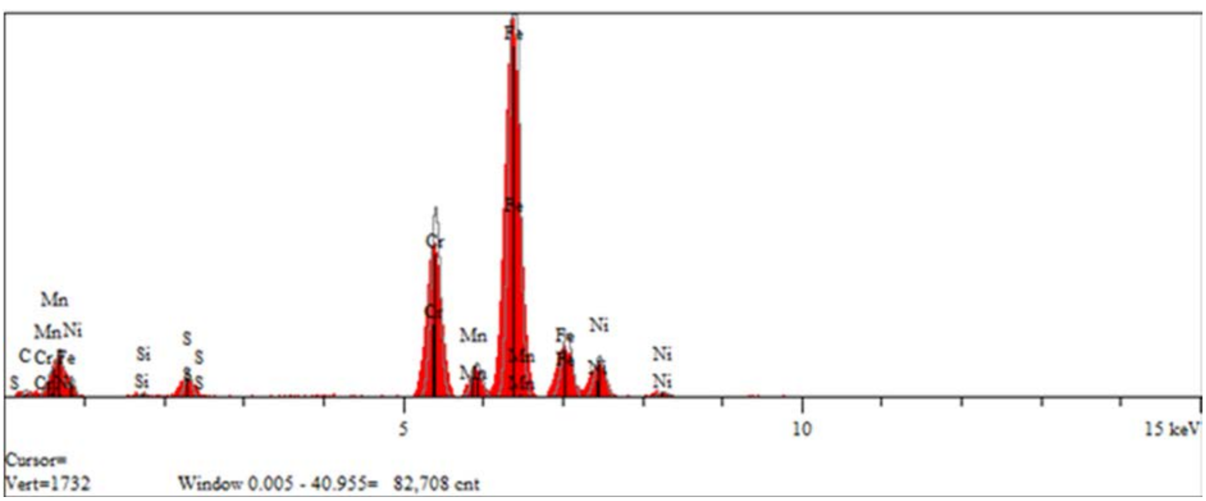


Figure O - 18 F303 Side 25X and EDX Elemental Analysis

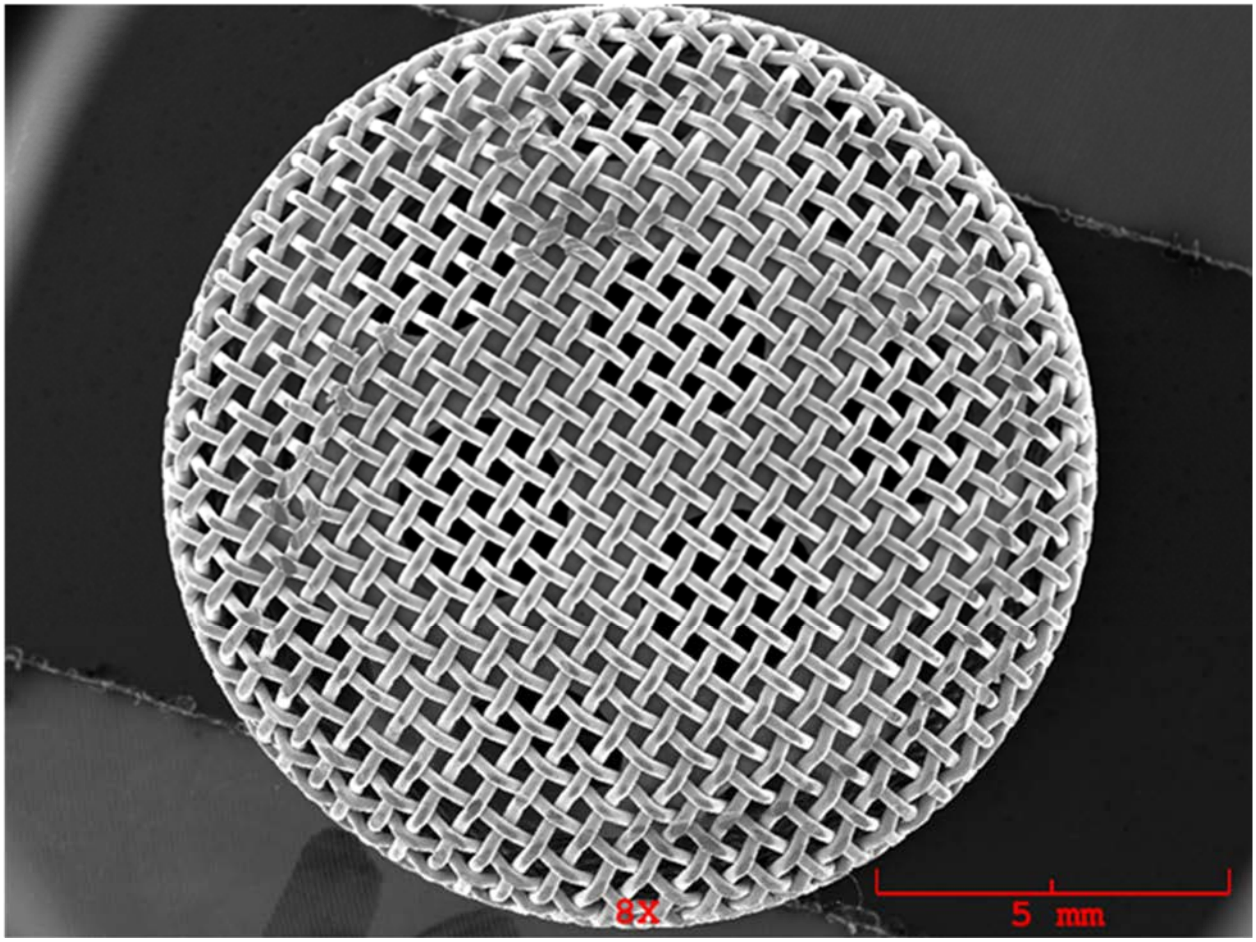
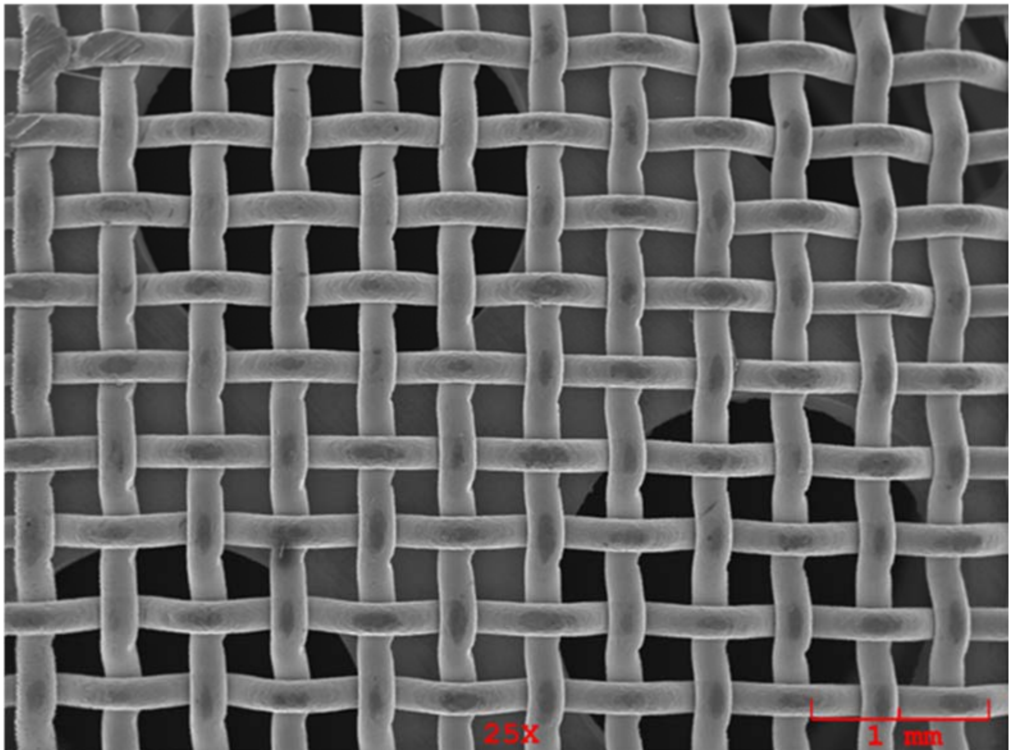


Figure O - 19 F304 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	6.98	4.888	wt.%	0.554	0.631	
S	Ka	21.42	2.272	wt.%	0.143	0.160	
Cr	Ka	98.44	14.513	wt.%	0.326	0.222	
Mn	Ka	4.92	0.992	wt.%	0.227	0.320	
Fe	Ka	265.82	64.306	wt.%	0.825	0.372	
Ni	Ka	23.21	8.410	wt.%	0.469	0.480	
Cu	Ka	10.31	4.619	wt.%	0.427	0.482	
			100.000	wt.%			Total

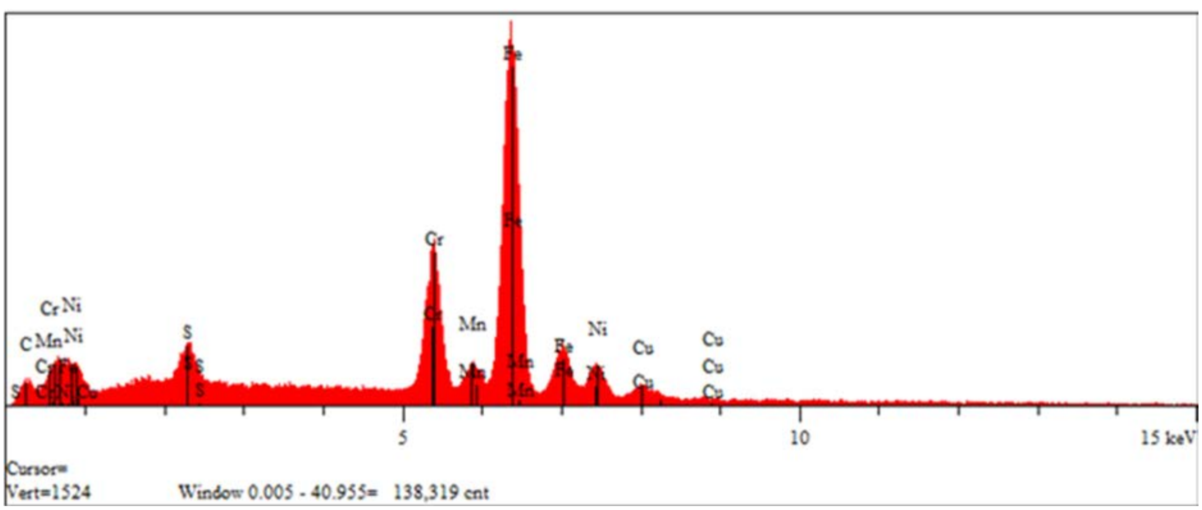


Figure O - 20 F304 Bottom, 25X and EDX Elemental Analysis

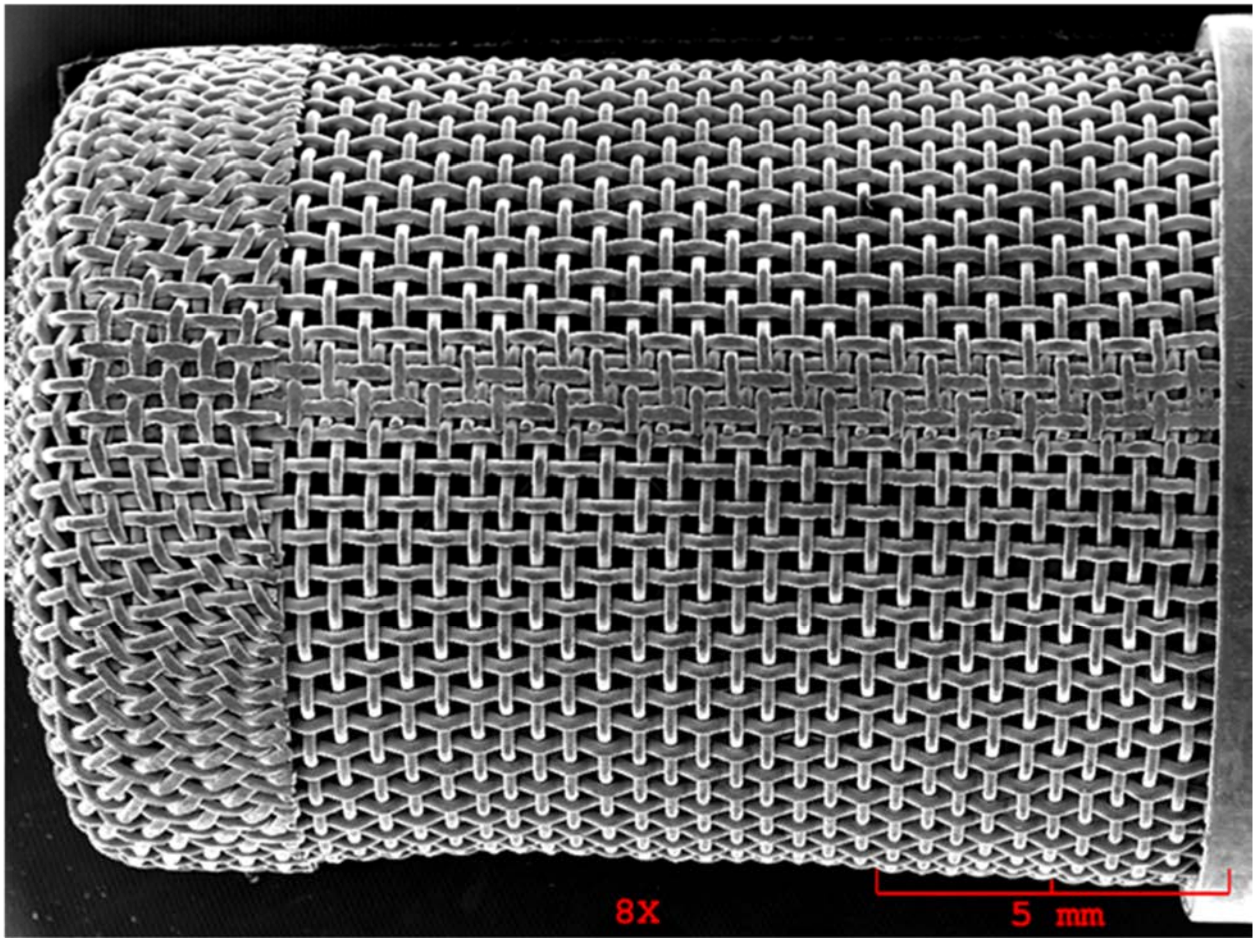
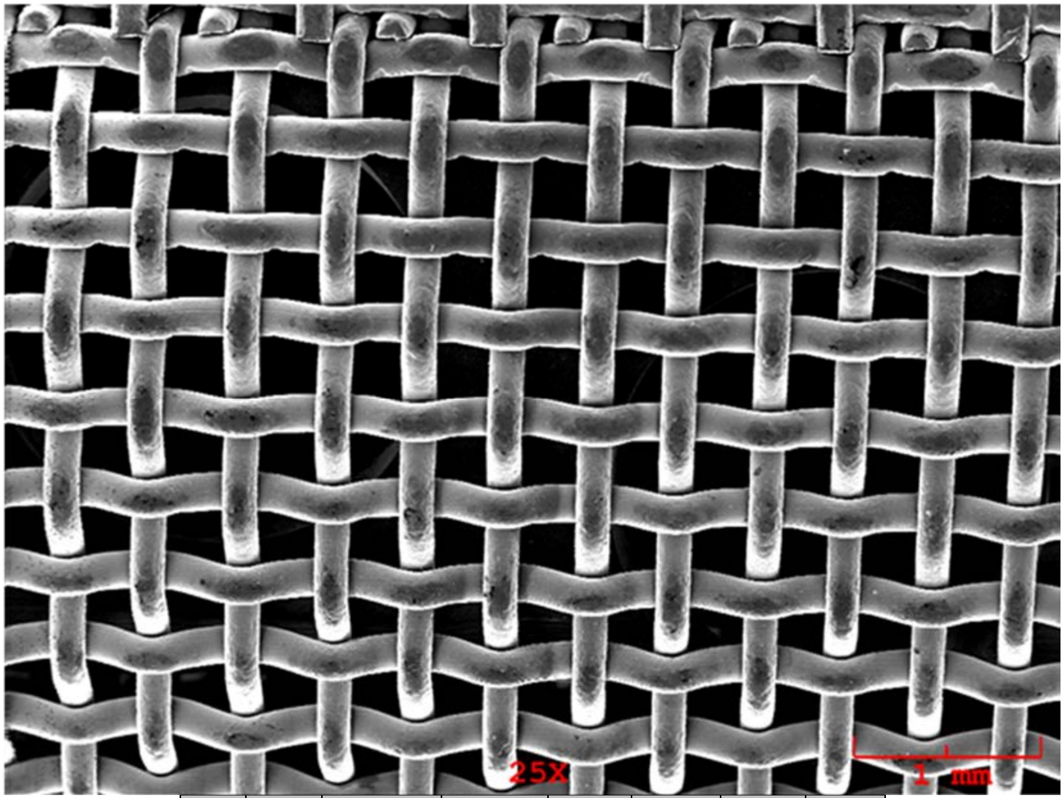


Figure O - 21 F304 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	7.60	4.341	wt.%	0.466	0.526	
Si	Ka	3.83	0.426	wt.%	0.113	0.159	
S	Ka	20.92	1.829	wt.%	0.121	0.140	
Cr	Ka	121.02	14.598	wt.%	0.293	0.188	
Mn	Ka	5.76	0.954	wt.%	0.198	0.278	
Fe	Ka	331.24	65.940	wt.%	0.755	0.323	
Ni	Ka	30.13	8.991	wt.%	0.416	0.393	
Cu	Ka	7.92	2.921	wt.%	0.353	0.437	
			100.000	wt.%			Total

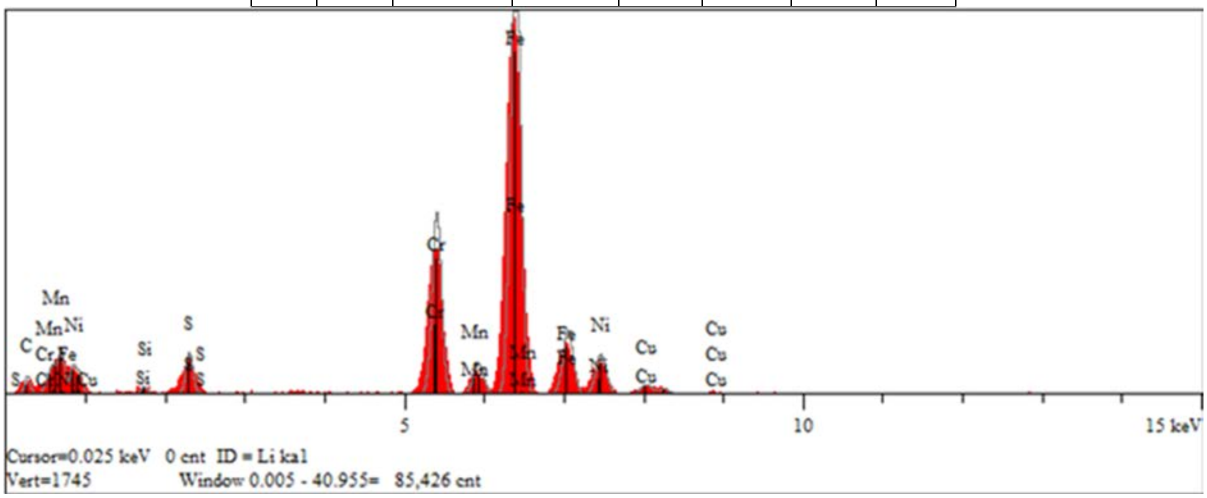


Figure O - 22 F304 Side, 25X and EDX Elemental Analysis

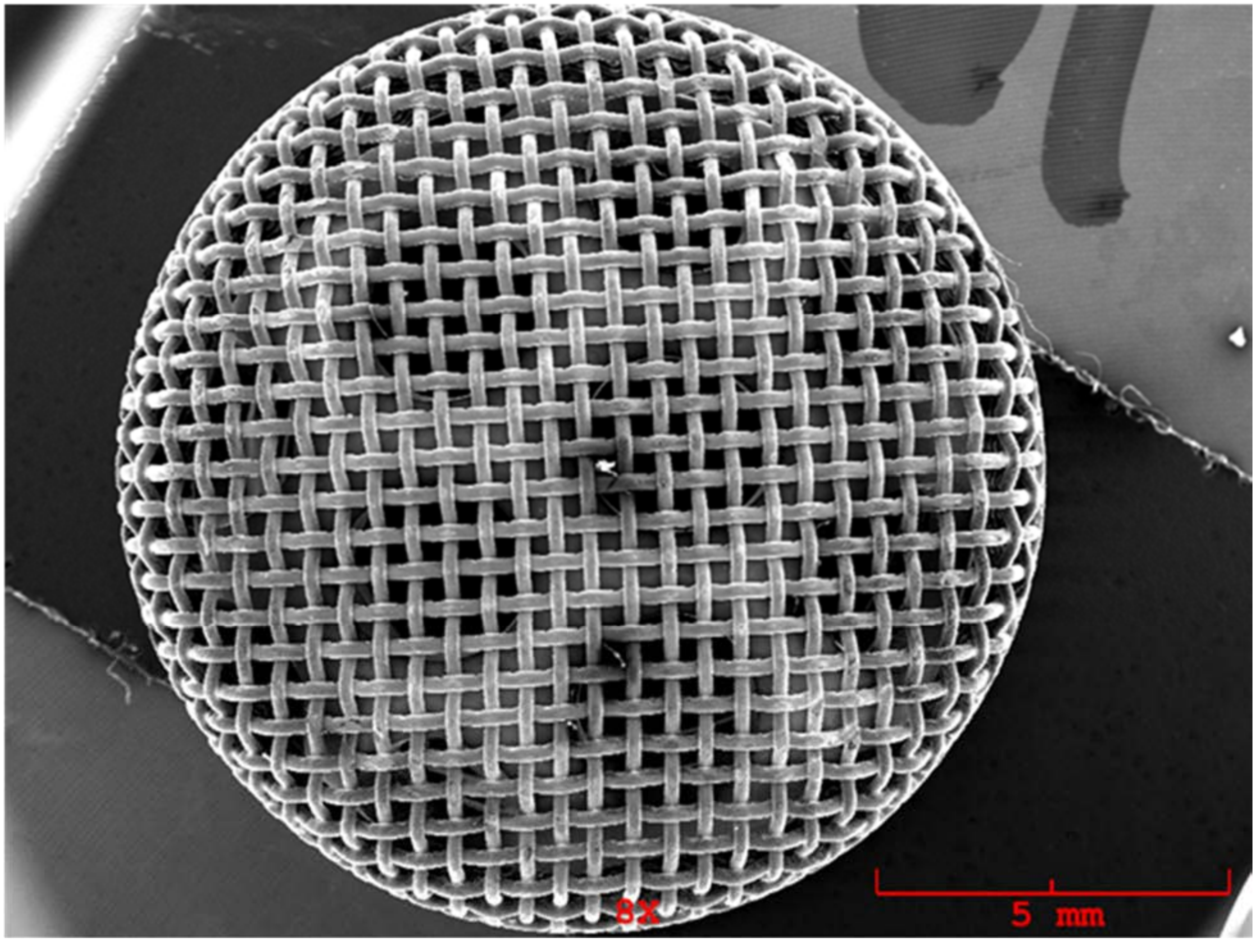
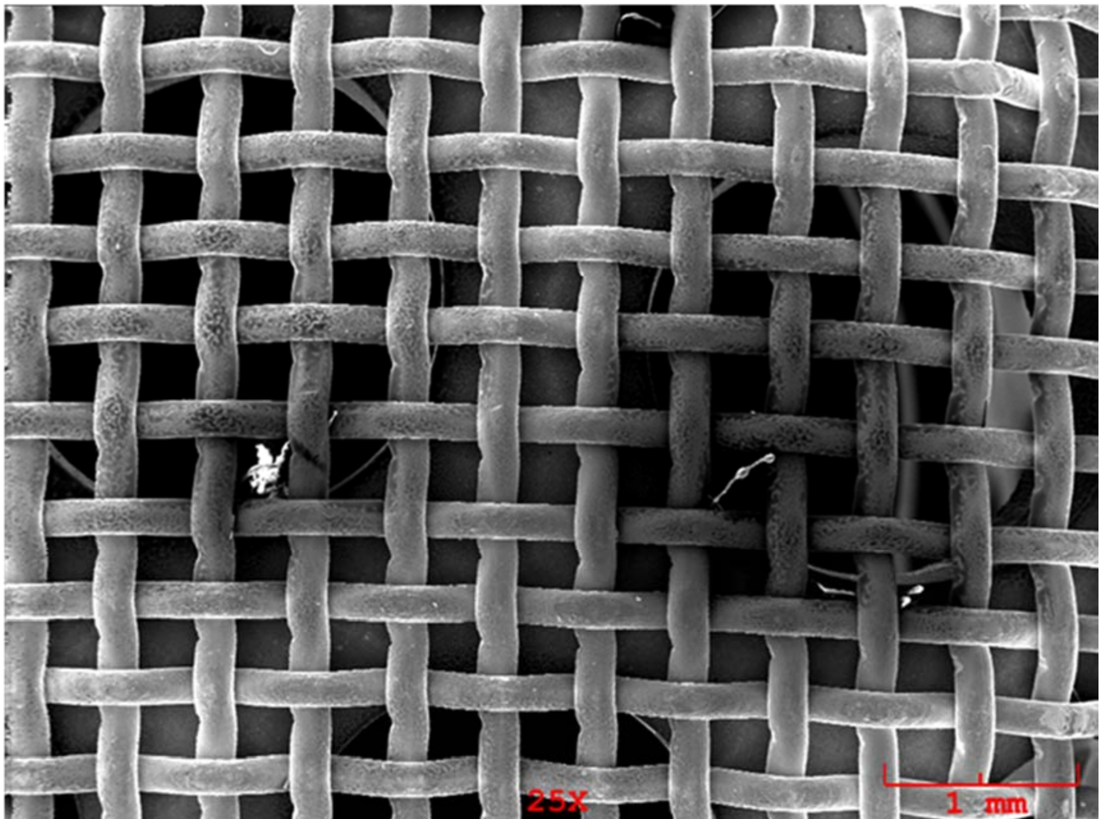


Figure O - 23 F702 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	24.13	16.621	wt.%	0.858	0.808	
Si	Ka	2.78	0.366	wt.%	0.123	0.176	
S	Ka	31.63	3.374	wt.%	0.156	0.151	
Cr	Ka	82.60	12.952	wt.%	0.315	0.206	
Mn	Ka	6.01	1.286	wt.%	0.217	0.290	
Fe	Ka	226.15	57.896	wt.%	0.802	0.343	
Ni	Ka	19.75	7.505	wt.%	0.437	0.425	
			100.000	wt.%			Total

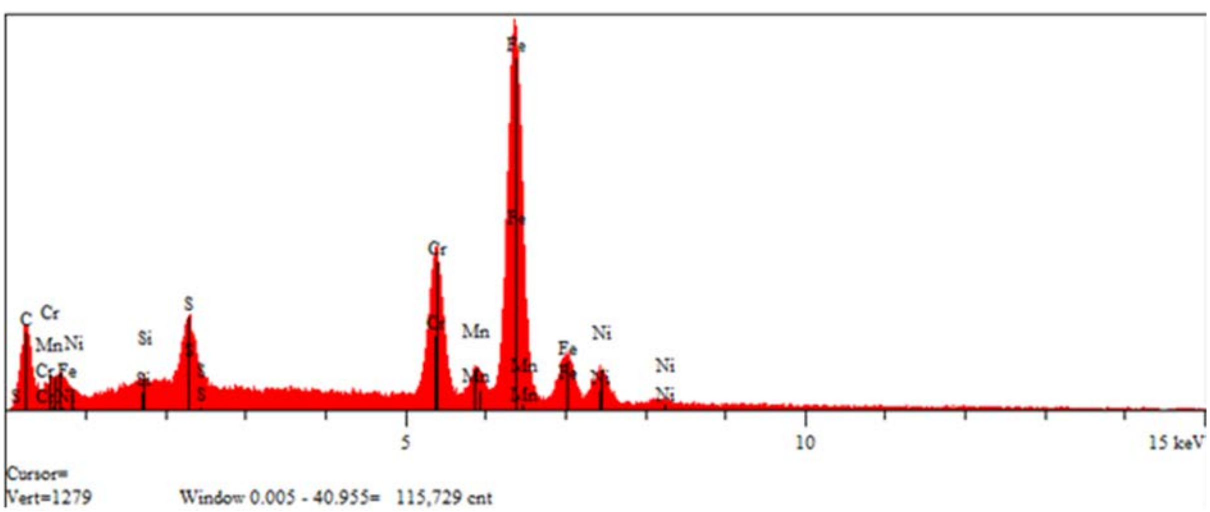


Figure O - 24 F702 Bottom, 25X and EDX Elemental Analysis

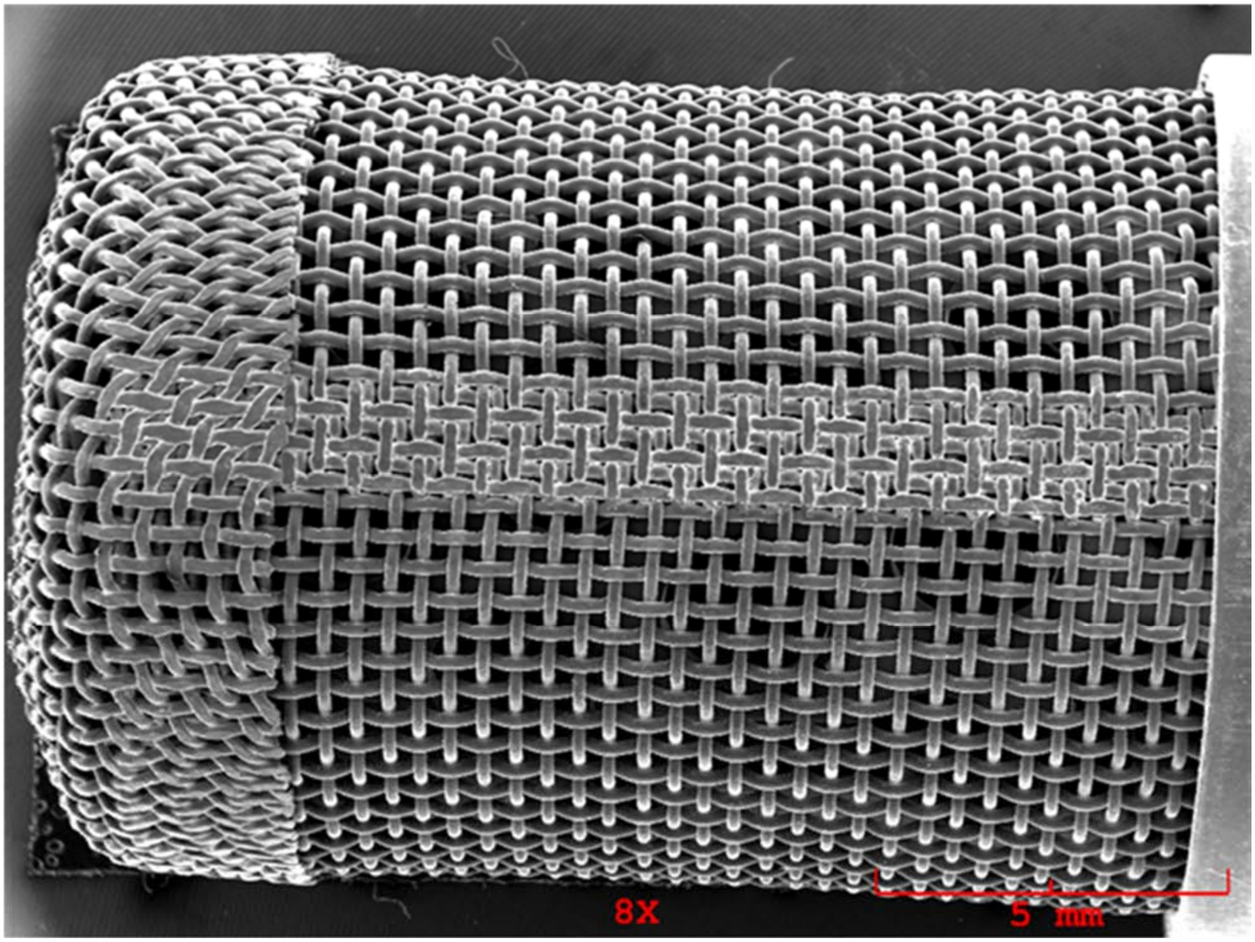
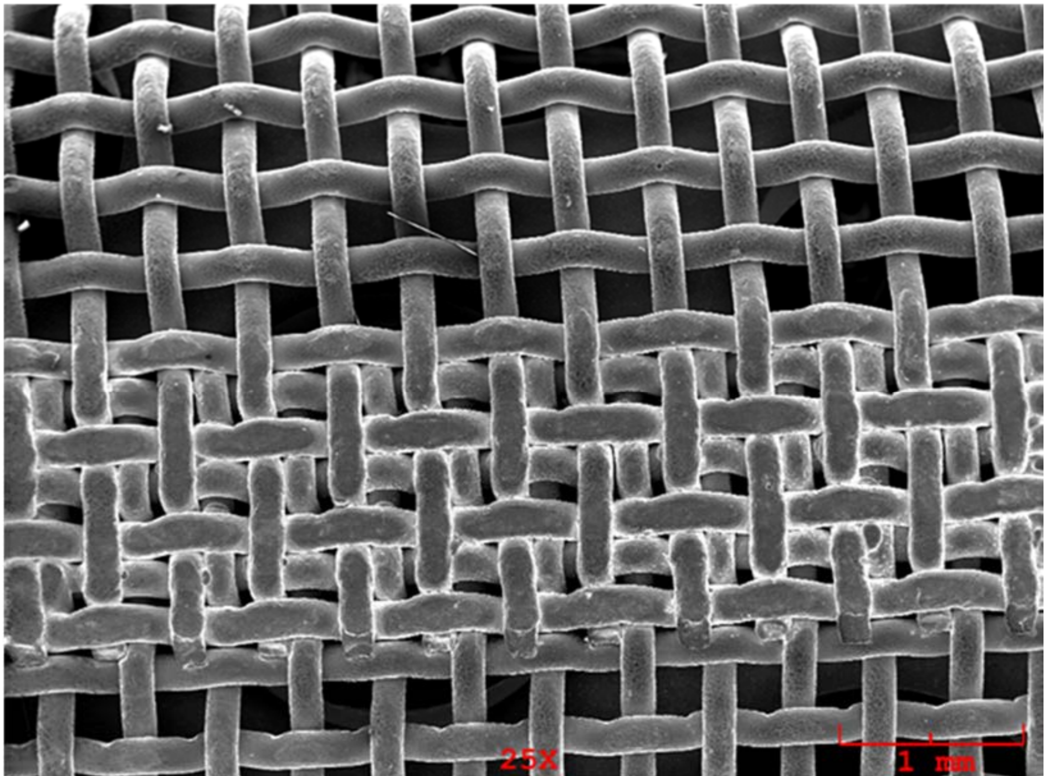


Figure O - 25 F702 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	22.79	12.141	wt.%	0.706	0.749	
Si	Ka	6.07	0.616	wt.%	0.109	0.148	
S	Ka	36.38	2.969	wt.%	0.130	0.131	
Cr	Ka	123.78	14.645	wt.%	0.290	0.185	
Mn	Ka	5.81	0.936	wt.%	0.191	0.267	
Fe	Ka	313.34	60.535	wt.%	0.714	0.315	
Ni	Ka	28.41	8.158	wt.%	0.396	0.385	
			100.000	wt.%			Total

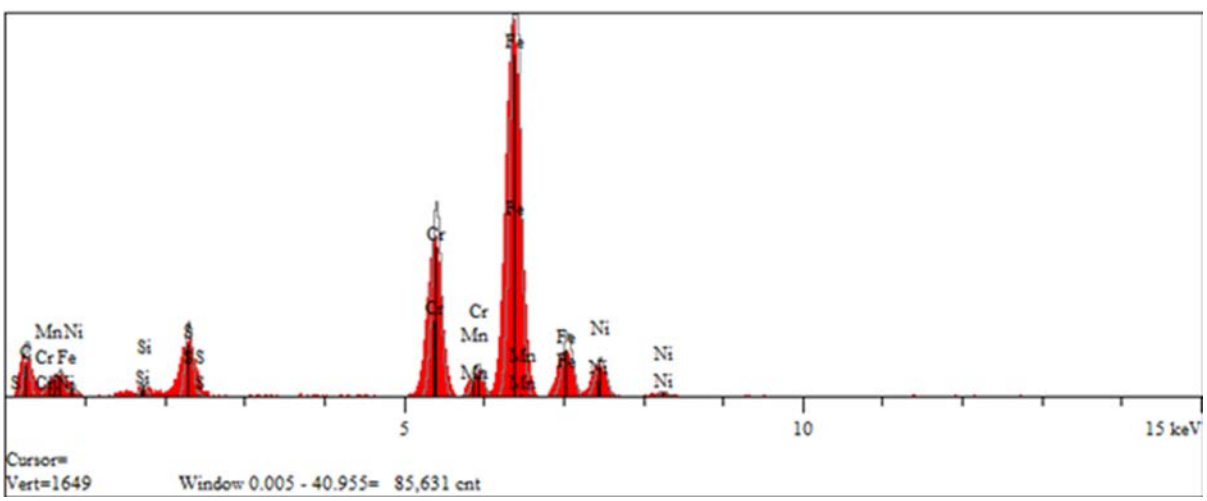


Figure O -26 F702 Side, 25X and EDX Elemental Analysis

APPENDIX P - RUN 162 DATA PACKAGE

Run Conditions: EDTST Mode, MT Conditions
Fuel ID: POSF-12843, Ft McCoy **with 5.7 mg/L MDA**
Airframe Heat Exchanger Bulk Fuel Output: 285 °F
HP Pump HX Out/FCOC Bulk Fuel In: 325 °F
Fuel-Cooled Oil Cooler Bulk Fuel Output: 350 °F
Burner Feed Arm Max Wetted Wall Temperature: 510 °F
Run Duration: 72 Hours

DATA SUMMARY

Run 162; Run Type: EDTST; Op Mode: MT; MSNs: N/A; EDTST Run Hours: 72 Fuel ID#: POSF12911; Run Tank: Drums; Run Type: EDTST; Op Mode: MT Fuel Type: F-24; Additive(s): MDA AFHX Out: 285 °F; FCOC In: 325 °F; FCOC Out: 350 °F; BFA MWWT: 510 °F;

Component/Device	Serial No.	Pre-Test %	Post-Test %	Spread (Pre/Post Delta), %	Shift, PPH	Skew, PSID	Flow Range Shift, PPH	Flow Midpoint Shift, PPH	Overall Rating	Hysteresis Area Change (PPH-DP)
FDV	1257	-4.9	30.3	35.2	1.5	0.5	-1.3	-0.7	Moderate	59
Servo2	024	8.9	14.8	5.9	-1.4	-0.7	-0.9	-0.4	Moderate	227

Effective Carbon - µgrams

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	36.2	31.6	40.9	44.0	36.3					
BFA	31.6	56.3	109.8	271.6	405.5	1151.3	2039.5	1967.3	1184.4	633.8
Total FCOC Carbon, µgrams	188.9	µgrams	0.2	mgrams						
Total BFA Carbon, µgrams	7851.1	µgrams	7.9	mgrams						

SCREENS	Total Carbon, µg	Background Carbon, µg	Effective Carbon, µg	MWWT Start	MWWT End	Delta BFA MWWT	TE	BFA AWWT Start	BFA AWWT End	Delta BFA AWWT
TMS	25.0	0.3	24.7	510.12	537.33	29.31	MAX	491.69	505.49	13.80
F303	107.8	25.4	82.4	505.14	526.73	21.58	TE325	SV Inlet	FDV Inlet	BFA Inlet
F304	75.7	12.9	62.8	510.12	537.31	27.19	TE324	(TE702)	(TE313)	(TE316)
F305	0.0	0.0	0.0	508.02	537.33	29.31	TE323	343	329	326
F702	81.2	12.9	68.3	506.47	533.48	27.01	TE322			

Effective Carbon Deposition - µgrams/cm^2

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	9.9	8.6	11.2	12.1	10.0					
BFA	18.3	32.7	63.7	157.7	235.4	668.3	1183.8	1141.9	687.5	367.9

TMS Mass Change - grams

Component/Device	Tare, g	Mass, g	Mass Gain, g
TMS	0.08668	0.08677	0.00009
F303	7.14655	7.14671	0.00016
F304	3.05094	3.05094	0.00000
F305	0.00000	0.00000	0.00000
F702	3.05678	3.05669	-0.00009

Hysteresis Ratings:

- NONE: indicating that the pre-test and post-test hysteresis curves, for all intents and purposes, are nearly indistinguishable from one another. Minor differences may be seen between the pre-test and post-test curves but these are very small.
- Minor: There are small differences between per- and post-test curves. The spread for these curves is typically within 5% of one another. There may be some small changes in shift and skew for the valve. This degree of hysteresis would not be expected to alter the functional nature of the valve.
- Moderate: There are definite differences between pre-and post-test curves. There may be definite differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically between 5% and 15%. This degree of hysteresis might be expected to alter the functional nature of the valve.
- Severe: There are pronounce differences between pre-and post-test curves. There may be pronounced differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically in excess 15%. This degree of hysteresis would be considered out-of-spec for the valve.
- Non-Functional: There are major differences between pre-and post-test curves. There may be major differences in shift and skew as well. The hysteresis curve will exhibit flat segments (either vertically or horizontally). Shift and skew have majorly changed the performance envelope of the valve. This degree of hysteresis would cause the valve to be non-functional or unresponsive over small or large portions of the performance range of the valve.

Figure P - 1 Run 162 Data Summary

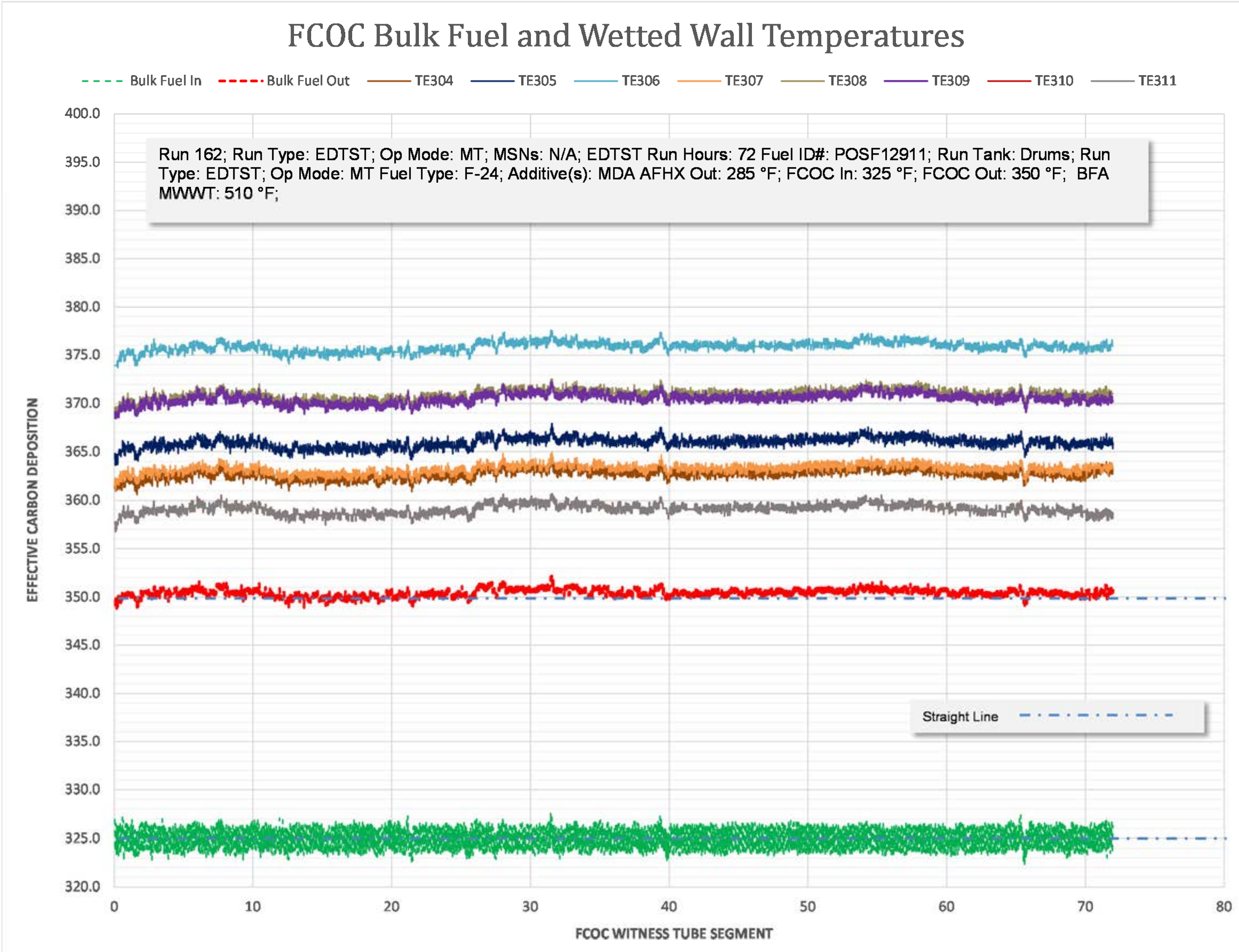


Figure P - 2 FCOC Bulk Fuel and Wetted Wall Temperatures

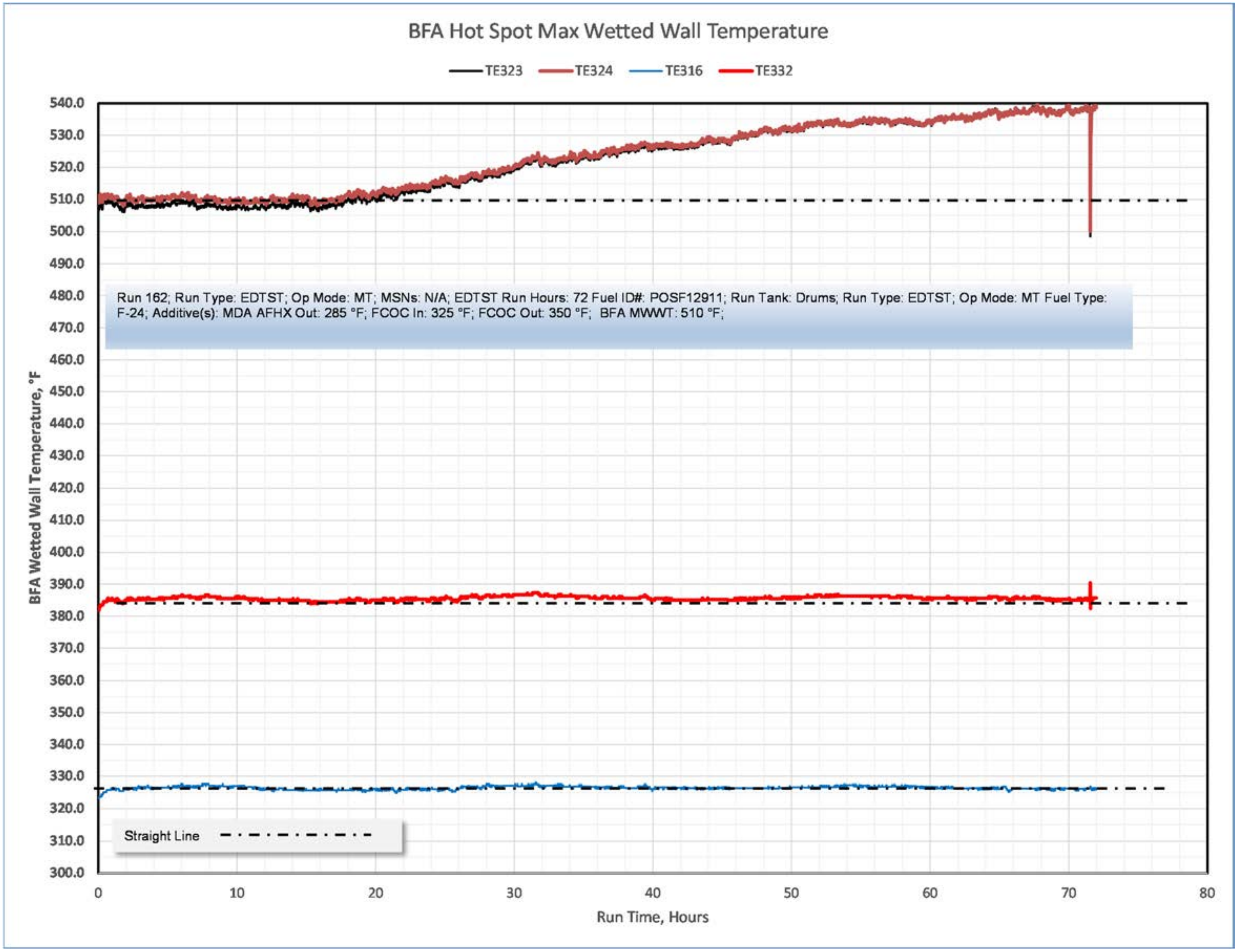


Figure P - 3 BFA Hot Spot Max Wetted Wall And Bulk Fuel Temperatures

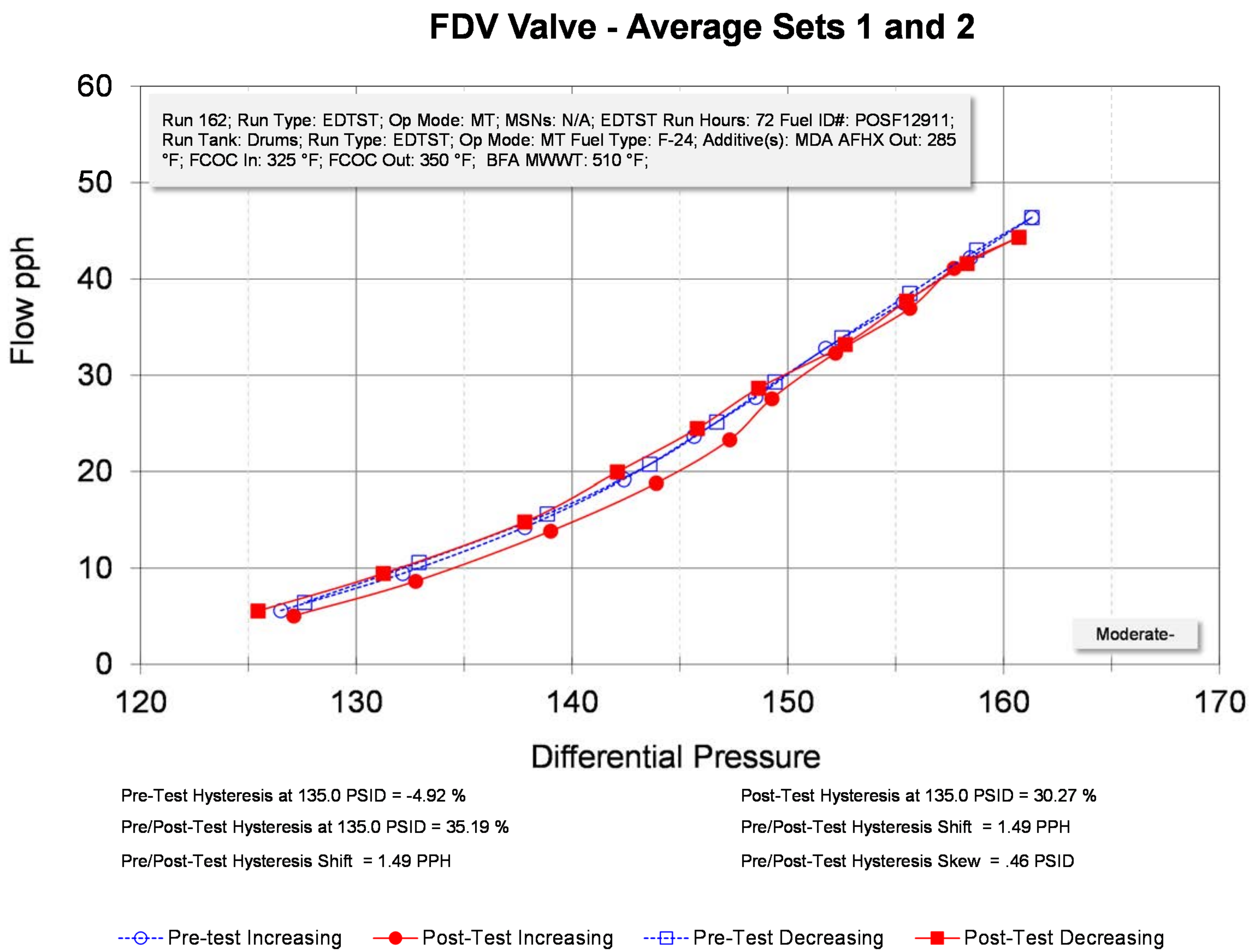


Figure P - 4 FDV Hysteresis

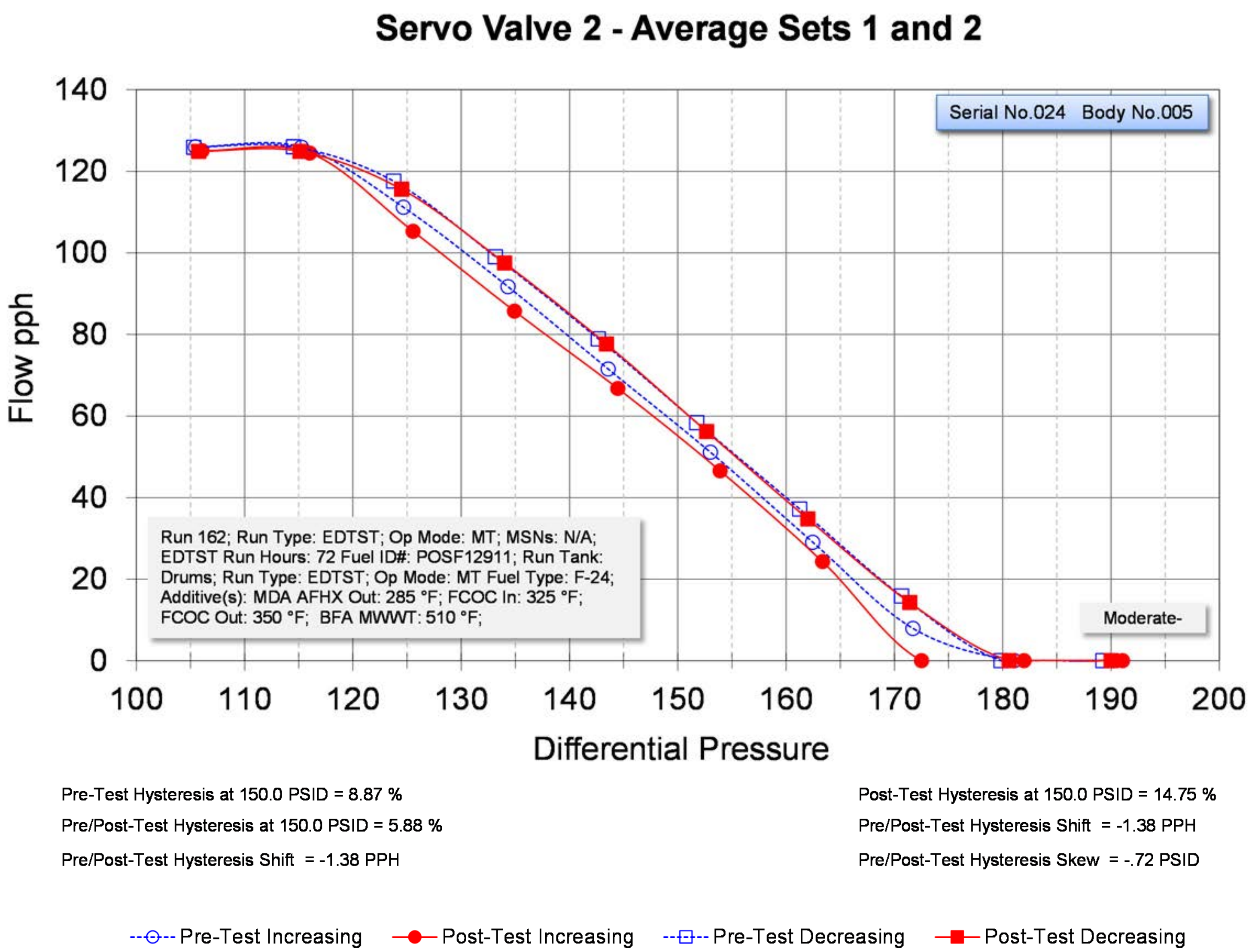


Figure P - 5 Servo Valve Hysteresis

Figure P - 6 FDV Components - Comparison to Clean

Servo Valve and Nozzle Screen Simulator Components – Comparison To Clean - Run 162

Run 162

Clean

POSF-12843 MT with MDA Additive

Figure P - 7 Servo Valve and Nozzle Screen Components - Comparison to Clean

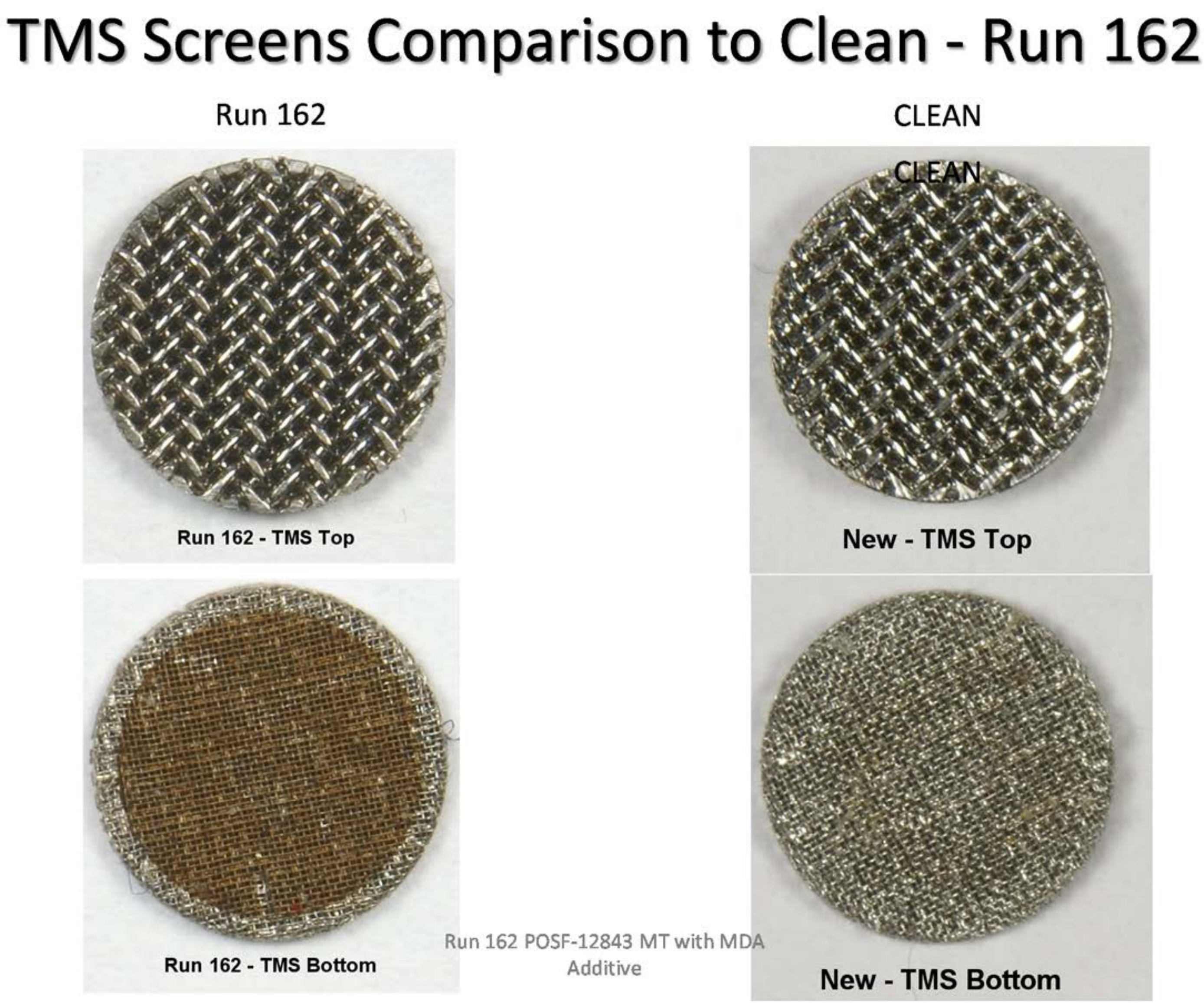


Figure P - 8 TMS Screen Top and Bottom - Comparison to Clean

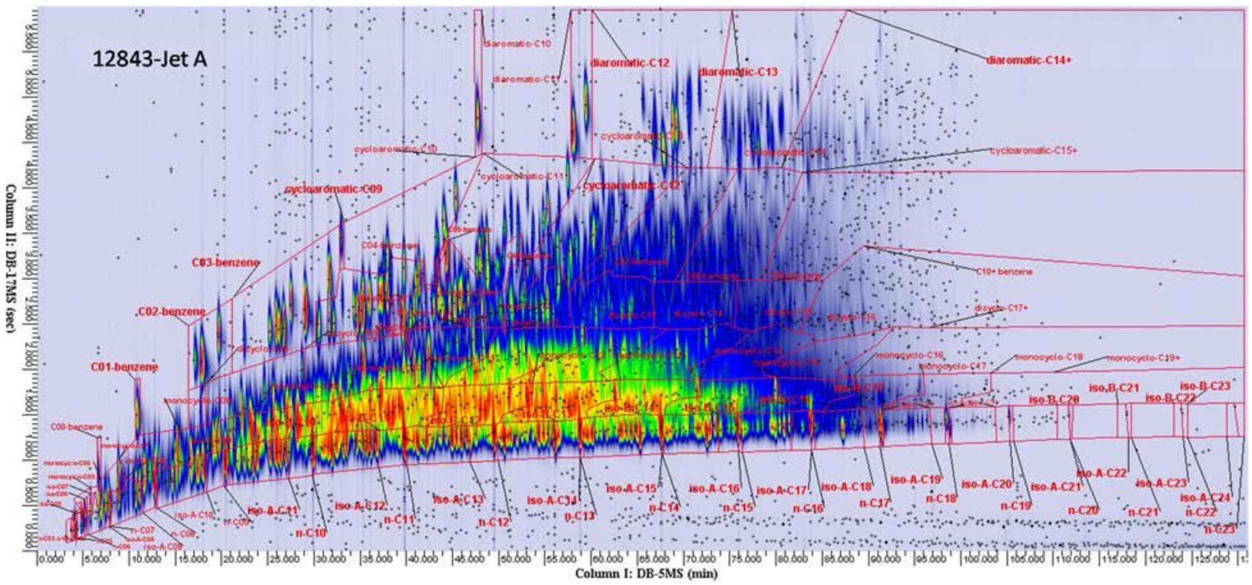


Figure P - 9 GCxGC Summary POSF-12843 Neat Fuel

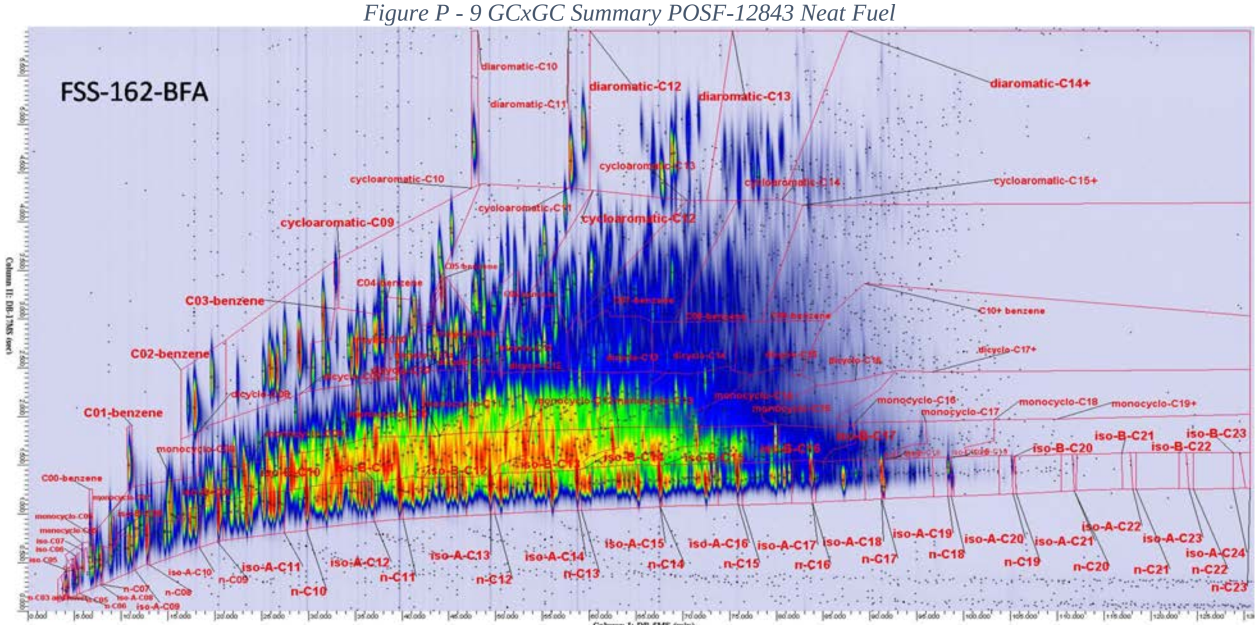


Figure P - 10 GCxGC Summary POSF-12843 BFA Outlet

Table P - 1 GCxGC Tabulated Data POSF-12843 Jet A Neat and Run 155 BFA Outlet

GCxGC Summary					
Hydrogen content (weight %)	13.9			13.9	
Average Molecular Wt (g/mole)	163			163	
	POSF-12843- Jet A			12913-FSS162-BFA	
	Weight %	Volume %		Weight %	Volume %
Aromatics					
Alkylbenzenes					
benzene (C06)	<0.01	<0.01		<0.01	<0.01
toluene (C07)	0.12	0.11		0.11	0.10
C2-benzene (C08)	0.56	0.52		0.55	0.51
C3-benzene (C09)	1.90	1.77		1.87	1.74
C4-benzene (C10)	2.45	2.29		2.46	2.29
C5-benzene (C11)	1.86	1.72		1.85	1.71
C6-benzene (C12)	1.62	1.51		1.59	1.48
C7-benzene (C13)	1.00	0.93		0.93	0.86
C8-benzene (C14)	0.83	0.77		0.81	0.76
C9-benzene (C15)	0.59	0.55		0.57	0.53
C10+-benzene (C16+)	0.40	0.37		0.39	0.36
Total Alkylbenzenes	**11.35**	10.56		**11.13**	10.34
Diaromatics (Naphthalenes, Biphenyls, etc.)					
diaromatic-C10	0.11	0.08		0.10	0.08
diaromatic-C11	0.42	0.33		0.41	0.32
diaromatic-C12	0.73	0.58		0.71	0.57
diaromatic-C13	0.51	0.42		0.50	0.41
diaromatic-C14+	0.31	0.26		0.30	0.24
Total Alkylnaphthalenes	**2.08**	1.67		**2.02**	1.62
Cycloaromatics (Indans, Tetralins,etc.)					
cycloaromatic-C09	0.04	0.04		0.04	0.04
cycloaromatic-C10	0.37	0.30		0.38	0.31
cycloaromatic-C11	0.87	0.75		0.87	0.74
cycloaromatic-C12	1.16	1.01		1.17	1.02
cycloaromatic-C13	1.47	1.29		1.48	1.29
cycloaromatic-C14	0.83	0.73		0.86	0.75
cycloaromatics-C15+	0.41	0.36		0.40	0.35
Total Cycloaromatics	**5.16**	4.47		**5.20**	4.50
Total Aromatics	**18.59**	**16.70**		**18.35**	**16.47**
Paraffins					
iso-Paraffins					
C07 & lower -isoparaffins	0.22	0.27		0.19	0.23
C08-isoparaffins	0.44	0.50		0.44	0.50
C09-isoparaffins	0.84	0.94		0.78	0.88
C10-isoparaffins	3.27	3.60		3.28	3.62
C11-isoparaffins	4.25	4.59		4.36	4.70
C12-isoparaffins	3.56	3.85		3.61	3.90
C13-isoparaffins	3.40	3.59		3.42	3.61
C14-isoparaffins	3.18	3.34		3.21	3.37
C15-isoparaffins	2.29	2.39		2.44	2.55
C16-isoparaffins	1.06	1.10		1.10	1.14
C17-isoparaffins	0.56	0.58		0.51	0.52
C18-isoparaffins	0.15	0.15		0.14	0.15
C19-isoparaffins	0.08	0.08		0.05	0.05
C20-isoparaffins	0.03	0.03		0.03	0.03
C21-isoparaffins	<0.01	<0.01		<0.01	<0.01
C22-isoparaffins	<0.01	<0.01		<0.01	<0.01
C23-isoparaffins	<0.01	<0.01		<0.01	<0.01
C24-isoparaffins	<0.01	<0.01		<0.01	<0.01
Total iso-Paraffins	**23.31**	25.01		**23.57**	25.26

n-Paraffins					
n-C07 & lower	0.17	0.20		0.17	0.20
n-C08	0.43	0.49		0.37	0.42
n-C09	1.01	1.13		1.00	1.11
n-C10	2.54	2.79		2.56	2.80
n-C11	3.01	3.26		3.17	3.43
n-C12	2.52	2.70		2.53	2.70
n-C13	2.00	2.12		2.02	2.14
n-C14	1.54	1.62		1.53	1.61
n-C15	0.89	0.93		0.89	0.93
n-C16	0.43	0.44		0.44	0.46
n-C17	0.20	0.20		0.22	0.22
n-C18	0.04	0.04		0.04	0.04
n-C19	<0.01	<0.01		<0.01	<0.01
n-C20	<0.01	<0.01		<0.01	<0.01
n-C21	<0.01	<0.01		<0.01	<0.01
n-C22	<0.01	<0.01		<0.01	<0.01
n-C23	<0.01	<0.01		<0.01	<0.01
Total n-Paraffins	**14.80**	15.93		**14.96**	16.09
Cycloparaffins					
Monocycloparaffins					
C07 & lower monocycloparaffins	0.42	0.43		0.43	0.45
C08-monocyclocycloparaffins	0.63	0.64		0.66	0.67
C09-monocyclocycloparaffins	1.82	1.84		1.92	1.94
C10-monocyclocycloparaffins	4.60	4.50		4.37	4.28
C11-monocyclocycloparaffins	6.32	6.36		6.31	6.33
C12-monocyclocycloparaffins	5.57	5.57		5.46	5.46
C13-monocyclocycloparaffins	5.07	5.02		4.93	4.87
C14-monocyclocycloparaffins	3.15	3.12		3.33	3.30
C15-monocyclocycloparaffins	2.10	2.07		2.00	1.98
C16-monocyclocycloparaffins	0.86	0.85		0.95	0.94
C17-monocyclocycloparaffins	0.33	0.32		0.41	0.40
C18-monocyclocycloparaffins	0.05	0.05		0.05	0.05
C19+-monocyclocycloparaffins	<0.01	<0.01		<0.01	<0.01
Total Monocycloparaffins	**30.93**	30.78		**30.83**	30.67
Dicycloparaffins					
C08-dicycloparaffins	0.02	0.02		0.02	0.02
C09-dicycloparaffins	0.45	0.42		0.49	0.45
C10-dicycloparaffins	1.01	0.90		1.05	0.93
C11-dicycloparaffins	2.32	2.17		2.21	2.07
C12-dicycloparaffins	2.69	2.54		2.74	2.59
C13-dicycloparaffins	3.00	2.83		3.36	3.17
C14-dicycloparaffins	1.94	1.83		1.70	1.60
C15-dicycloparaffins	0.60	0.56		0.47	0.44
C16-dicycloparaffins	0.21	0.20		0.18	0.17
C17+-dicycloparaffins	0.04	0.03		0.02	0.02
Total Dicycloparaffins	**12.27**	11.51		**12.23**	11.46
Tricycloparaffins					
C10-tricycloparaffins	<0.01	<0.01		<0.01	<0.01
C11-tricycloparaffins	0.09	0.07		0.06	0.05
C12-tricycloparaffins	<0.01	<0.01		<0.01	<0.01
Total Tricycloparaffins	**0.09**	0.08		**0.06**	0.05
Total Cycloparaffins	**43.29**	42.36		**43.12**	42.18
Average Molecular Formula - C	11.7			11.7	
Average Molecular Formula - H	22.4			22.4	

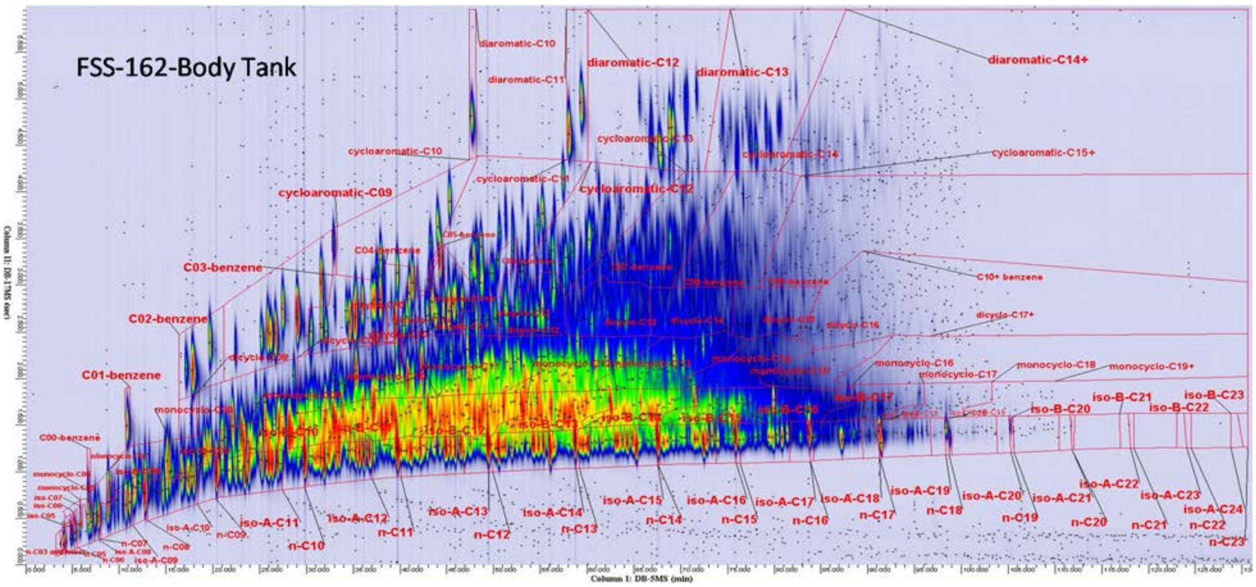


Figure P - 11 GCxGC Summary Fuel From Body Tank

Table P - 2 GCxGC Tabulated Data - Fuel From Body Tank at the End Of Run

GCxGC Summary				
Hydrogen content (weight %)	13.9		13.9	
Average Molecular Wt (g/mole)	163		163	
	POSF-12843- Jet A		12913-FSS162-Body Tank	
	Weight %	Volume %	Weight %	Volume %
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	<0.01	<0.01
toluene (C07)	0.12	0.11	0.11	0.10
C2-benzene (C08)	0.56	0.52	0.55	0.51
C3-benzene (C09)	1.90	1.77	1.87	1.74
C4-benzene (C10)	2.45	2.29	2.46	2.29
C5-benzene (C11)	1.86	1.72	1.85	1.72
C6-benzene (C12)	1.62	1.51	1.52	1.41
C7-benzene (C13)	1.00	0.93	0.94	0.87
C8-benzene (C14)	0.83	0.77	0.82	0.76
C9-benzene (C15)	0.59	0.55	0.56	0.52
C10+-benzene (C16+)	0.40	0.37	0.39	0.37
Total Alkylbenzenes	**11.35**	10.56	**11.07**	10.29
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.10	0.08
diaromatic-C11	0.42	0.33	0.41	0.32
diaromatic-C12	0.73	0.58	0.71	0.57
diaromatic-C13	0.51	0.42	0.50	0.40
diaromatic-C14+	0.31	0.26	0.28	0.23
Total Alkylnaphthalenes	**2.08**	1.67	**2.00**	1.61
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.04	0.04	0.04	0.03
cycloaromatic-C10	0.37	0.30	0.37	0.31
cycloaromatic-C11	0.87	0.75	0.86	0.74
cycloaromatic-C12	1.16	1.01	1.19	1.03
cycloaromatic-C13	1.47	1.29	1.47	1.29
cycloaromatic-C14	0.83	0.73	0.84	0.73
cycloaromatics-C15+	0.41	0.36	0.45	0.39
Total Cycloaromatics	**5.16**	4.47	**5.23**	4.52
Total Aromatics	**18.59**	**16.70**	**18.30**	**16.42**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.22	0.27	0.18	0.23
C08-isoparaffins	0.44	0.50	0.43	0.49
C09-isoparaffins	0.84	0.94	0.87	0.98
C10-isoparaffins	3.27	3.60	3.34	3.69
C11-isoparaffins	4.25	4.59	4.36	4.71
C12-isoparaffins	3.56	3.85	3.68	3.98
C13-isoparaffins	3.40	3.59	3.50	3.70
C14-isoparaffins	3.18	3.34	3.24	3.40
C15-isoparaffins	2.29	2.39	2.35	2.45
C16-isoparaffins	1.06	1.10	1.07	1.11
C17-isoparaffins	0.56	0.58	0.52	0.53
C18-isoparaffins	0.15	0.15	0.15	0.16
C19-isoparaffins	0.08	0.08	0.07	0.07
C20-isoparaffins	0.03	0.03	0.03	0.03
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01
Total iso-Paraffins	**23.31**	25.01	**23.81**	25.53

n-Paraffins				
n-C07 & lower	0.17	0.20	0.17	0.20
n-C08	0.43	0.49	0.42	0.47
n-C09	1.01	1.13	1.00	1.11
n-C10	2.54	2.79	2.54	2.78
n-C11	3.01	3.26	3.01	3.25
n-C12	2.52	2.70	2.50	2.67
n-C13	2.00	2.12	1.95	2.07
n-C14	1.54	1.62	1.51	1.58
n-C15	0.89	0.93	0.90	0.94
n-C16	0.43	0.44	0.42	0.44
n-C17	0.20	0.20	0.18	0.19
n-C18	0.04	0.04	0.04	0.04
n-C19	<0.01	<0.01	<0.01	<0.01
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**14.80**	15.93	**14.65**	15.76
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.42	0.43	0.44	0.46
C08-monocyclocycloparaffins	0.63	0.64	0.61	0.62
C09-monocyclocycloparaffins	1.82	1.84	1.77	1.79
C10-monocyclocycloparaffins	4.60	4.50	4.34	4.25
C11-monocyclocycloparaffins	6.32	6.36	6.35	6.38
C12-monocyclocycloparaffins	5.57	5.57	5.58	5.58
C13-monocyclocycloparaffins	5.07	5.02	5.15	5.08
C14-monocyclocycloparaffins	3.15	3.12	3.22	3.19
C15-monocyclocycloparaffins	2.10	2.07	1.98	1.96
C16-monocyclocycloparaffins	0.86	0.85	0.92	0.91
C17-monocyclocycloparaffins	0.33	0.32	0.40	0.40
C18-monocyclocycloparaffins	0.05	0.05	0.05	0.05
C19+-monocyclocycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Monocycloparaffins	**30.93**	30.78	**30.84**	30.67
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.45	0.42	0.53	0.48
C10-dicycloparaffins	1.01	0.90	1.01	0.90
C11-dicycloparaffins	2.32	2.17	2.18	2.05
C12-dicycloparaffins	2.69	2.54	2.82	2.66
C13-dicycloparaffins	3.00	2.83	3.20	3.02
C14-dicycloparaffins	1.94	1.83	1.69	1.60
C15-dicycloparaffins	0.60	0.56	0.67	0.63
C16-dicycloparaffins	0.21	0.20	0.20	0.19
C17+-dicycloparaffins	0.04	0.03	0.03	0.02
Total Dicycloparaffins	**12.27**	11.51	**12.35**	11.58
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.09	0.07	0.06	0.05
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.09**	0.08	**0.06**	0.05
Total Cycloparaffins	**43.29**	42.36	**43.24**	42.29
Average Molecular Formula - C	11.7		11.7	
Average Molecular Formula - H	22.4		22.4	

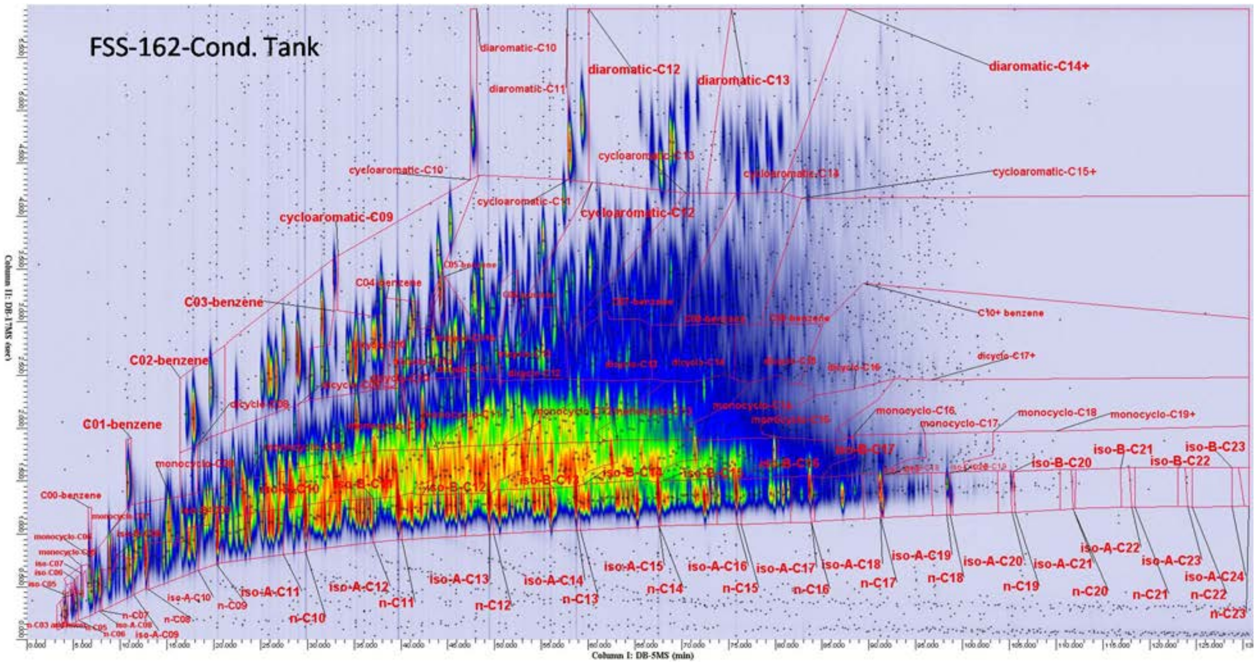


Figure P - 12 GCxGC Summary Fuel From Conditioning Tank

Table P - 3 GCxGC Tabulated Data - Fuel From Conditioning Tank at the End Of Run

GCxGC Summary				
Hydrogen content (weight %)	**13.9**		**13.9**	
Average Molecular Wt (g/mole)	**163**		**163**	
	POSF-12843- Jet A		**12911-FSS162-Cond. Tank**	
	Weight %	**Volume %**	**Weight %**	**Volume %**
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	<0.01	<0.01
toluene (C07)	0.12	0.11	0.11	0.10
C2-benzene (C08)	0.56	0.52	0.55	0.51
C3-benzene (C09)	1.90	1.77	1.87	1.74
C4-benzene (C10)	2.45	2.29	2.47	2.30
C5-benzene (C11)	1.86	1.72	1.82	1.69
C6-benzene (C12)	1.62	1.51	1.55	1.44
C7-benzene (C13)	1.00	0.93	1.00	0.93
C8-benzene (C14)	0.83	0.77	0.79	0.73
C9-benzene (C15)	0.59	0.55	0.59	0.55
C10+-benzene (C16+)	0.40	0.37	0.38	0.35
Total Alkylbenzenes	**11.35**	10.56	**11.14**	10.36
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.10	0.08
diaromatic-C11	0.42	0.33	0.41	0.32
diaromatic-C12	0.73	0.58	0.71	0.57
diaromatic-C13	0.51	0.42	0.50	0.40
diaromatic-C14+	0.31	0.26	0.28	0.23
Total Alkylnaphthalenes	**2.08**	1.67	**2.00**	1.61
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.04	0.04	0.04	0.04
cycloaromatic-C10	0.37	0.30	0.36	0.30
cycloaromatic-C11	0.87	0.75	0.89	0.77
cycloaromatic-C12	1.16	1.01	1.17	1.02
cycloaromatic-C13	1.47	1.29	1.51	1.32
cycloaromatic-C14	0.83	0.73	0.87	0.76
cycloaromatics-C15+	0.41	0.36	0.42	0.37
Total Cycloaromatics	**5.16**	4.47	**5.27**	4.56
Total Aromatics	**18.59**	**16.70**	**18.42**	**16.53**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.22	0.27	0.17	0.21
C08-isoparaffins	0.44	0.50	0.43	0.49
C09-isoparaffins	0.84	0.94	0.81	0.91
C10-isoparaffins	3.27	3.60	3.33	3.67
C11-isoparaffins	4.25	4.59	4.57	4.93
C12-isoparaffins	3.56	3.85	3.59	3.88
C13-isoparaffins	3.40	3.59	3.44	3.64
C14-isoparaffins	3.18	3.34	3.12	3.27
C15-isoparaffins	2.29	2.39	2.37	2.47
C16-isoparaffins	1.06	1.10	1.06	1.10
C17-isoparaffins	0.56	0.58	0.51	0.53
C18-isoparaffins	0.15	0.15	0.14	0.15
C19-isoparaffins	0.08	0.08	0.06	0.06
C20-isoparaffins	0.03	0.03	0.03	0.03
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01
Total iso-Paraffins	**23.31**	25.01	**23.62**	25.33

n-Paraffins				
n-C07 & lower	0.17	0.20	0.16	0.19
n-C08	0.43	0.49	0.41	0.47
n-C09	1.01	1.13	0.99	1.11
n-C10	2.54	2.79	2.63	2.88
n-C11	3.01	3.26	3.07	3.32
n-C12	2.52	2.70	2.44	2.61
n-C13	2.00	2.12	2.01	2.13
n-C14	1.54	1.62	1.52	1.60
n-C15	0.89	0.93	0.89	0.92
n-C16	0.43	0.44	0.43	0.45
n-C17	0.20	0.20	0.21	0.22
n-C18	0.04	0.04	0.04	0.04
n-C19	<0.01	<0.01	<0.01	<0.01
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**14.80**	15.93	**14.82**	15.95
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.42	0.43	0.45	0.47
C08-monocyclocycloparaffins	0.63	0.64	0.77	0.79
C09-monocyclocycloparaffins	1.82	1.84	1.69	1.70
C10-monocyclocycloparaffins	4.60	4.50	4.23	4.14
C11-monocyclocycloparaffins	6.32	6.36	6.26	6.29
C12-monocyclocycloparaffins	5.57	5.57	5.66	5.66
C13-monocyclocycloparaffins	5.07	5.02	4.97	4.91
C14-monocyclocycloparaffins	3.15	3.12	3.25	3.22
C15-monocyclocycloparaffins	2.10	2.07	1.98	1.96
C16-monocyclocycloparaffins	0.86	0.85	0.98	0.97
C17-monocyclocycloparaffins	0.33	0.32	0.41	0.41
C18-monocyclocycloparaffins	0.05	0.05	0.05	0.05
C19+-monocyclocycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Monocycloparaffins	**30.93**	30.78	**30.72**	30.56
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.45	0.42	0.54	0.50
C10-dicycloparaffins	1.01	0.90	1.08	0.96
C11-dicycloparaffins	2.32	2.17	2.23	2.10
C12-dicycloparaffins	2.69	2.54	2.80	2.64
C13-dicycloparaffins	3.00	2.83	3.11	2.93
C14-dicycloparaffins	1.94	1.83	1.79	1.69
C15-dicycloparaffins	0.60	0.56	0.60	0.56
C16-dicycloparaffins	0.21	0.20	0.16	0.15
C17+-dicycloparaffins	0.04	0.03	0.03	0.03
Total Dicycloparaffins	**12.27**	11.51	**12.36**	11.58
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.09	0.07	0.05	0.04
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.09**	0.08	**0.05**	0.04
Total Cycloparaffins	**43.29**	42.36	**43.13**	42.19
Average Molecular Formula - C	11.7		11.7	
Average Molecular Formula - H	22.4		22.4	

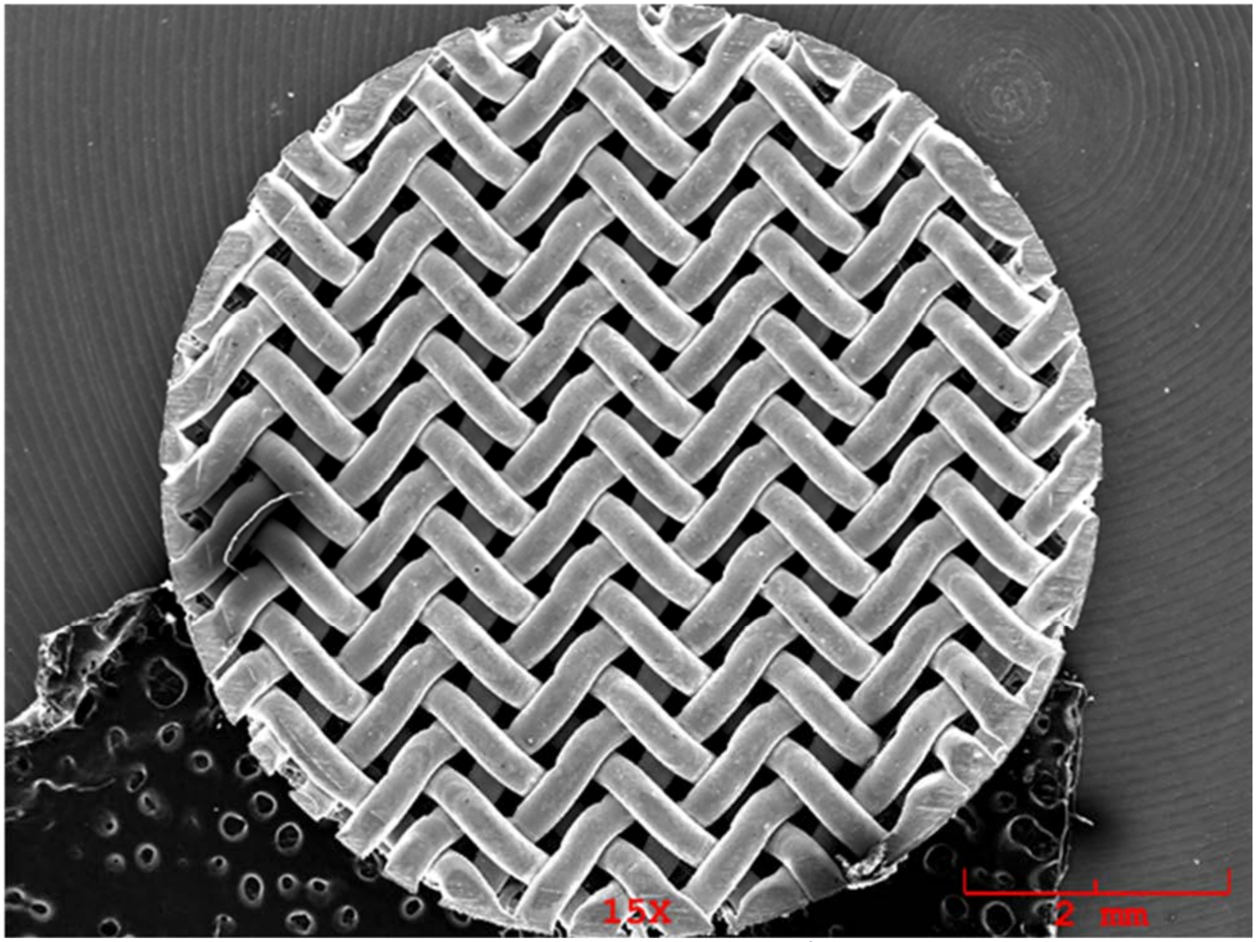
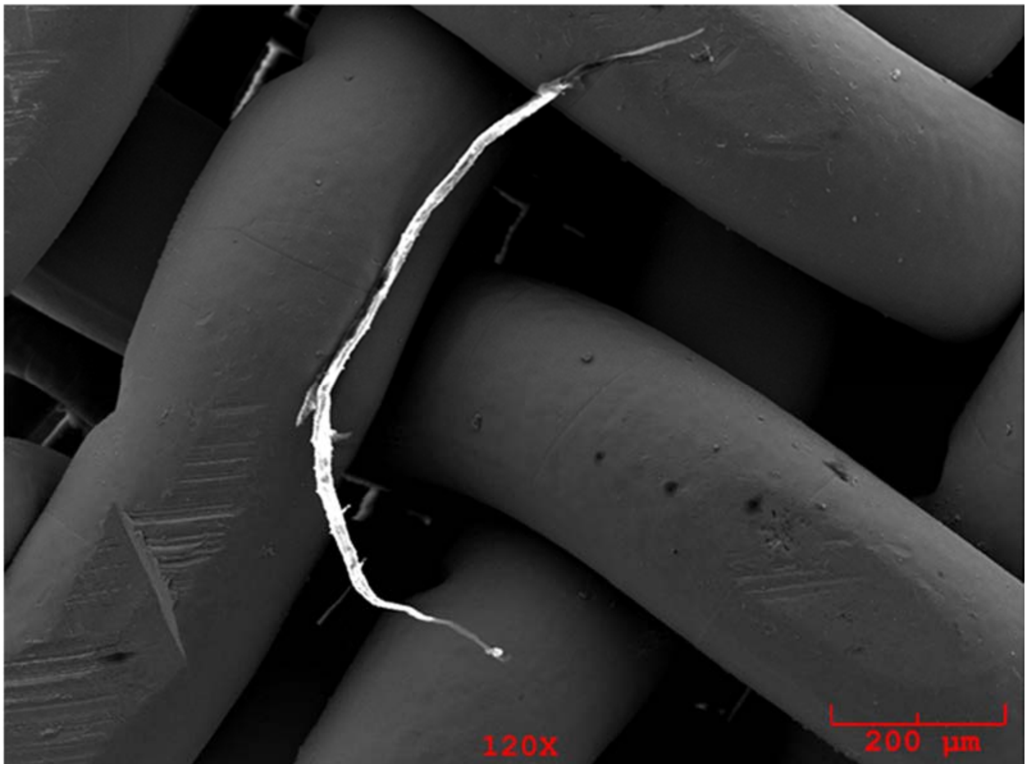


Figure P - 13 TMS Screen, Top, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	6.14	2.791	wt.%	0.385	0.478	
Al	Ka	120.32	11.238	wt.%	0.227	0.148	
S	Ka	9.02	0.584	wt.%	0.083	0.113	
Cr	Ka	172.46	15.546	wt.%	0.258	0.157	
Mn	Ka	9.84	1.192	wt.%	0.161	0.217	
Fe	Ka	421.65	61.176	wt.%	0.617	0.246	
Ni	Ka	34.74	7.473	wt.%	0.329	0.321	
			100.000	wt.%			Total

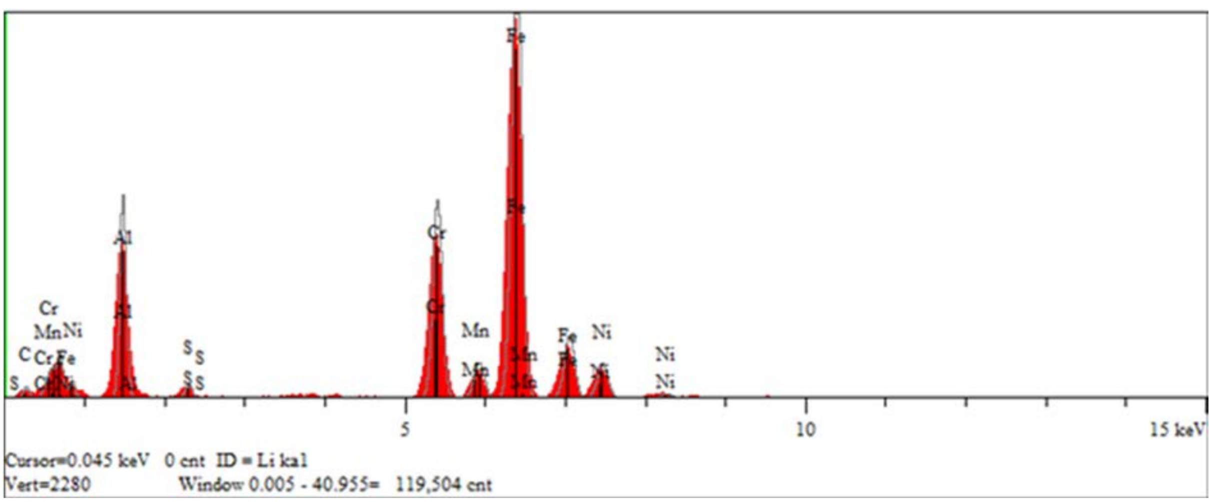


Figure P - 14 TMS Screen Top, 120X and EDX Elemental Analysis

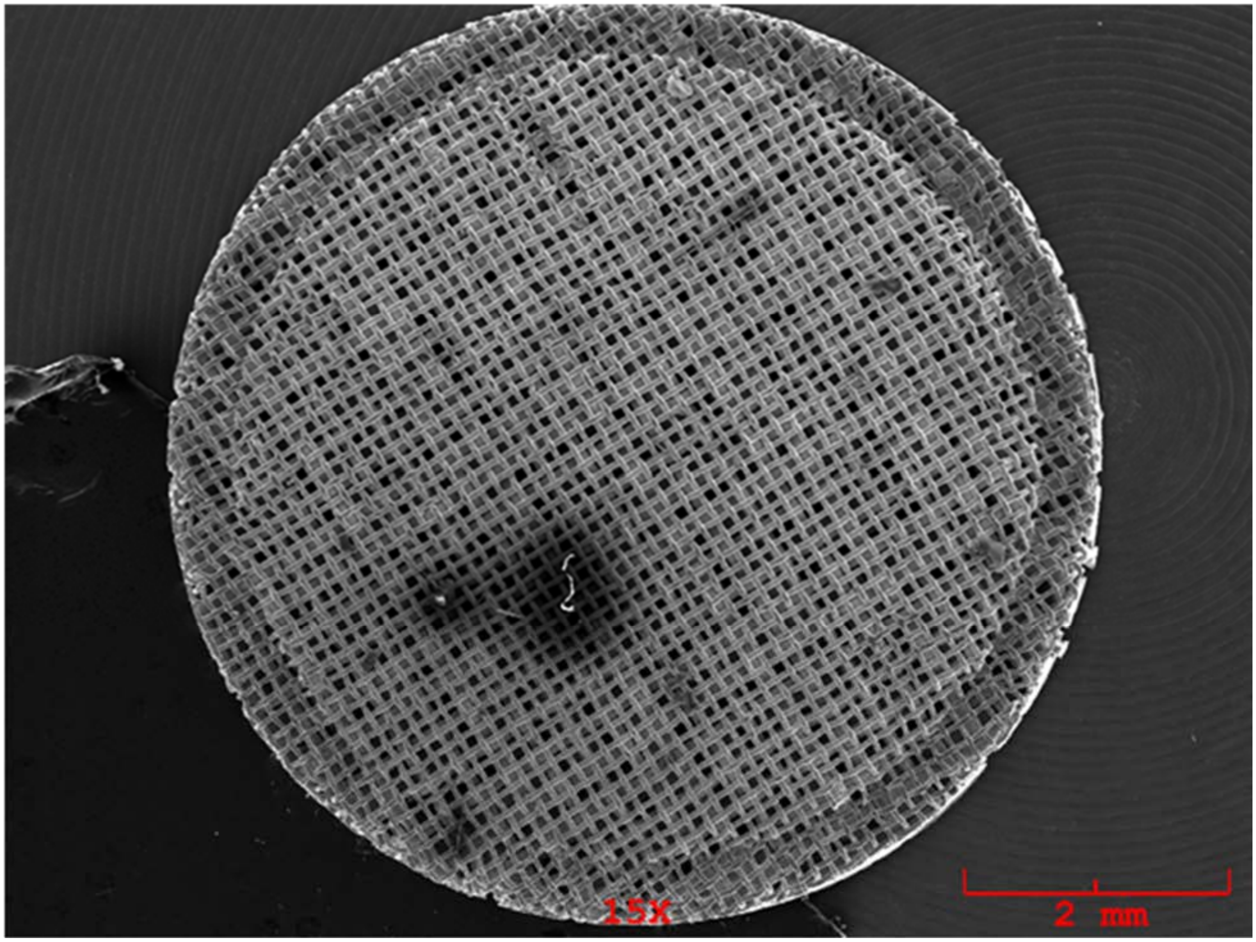
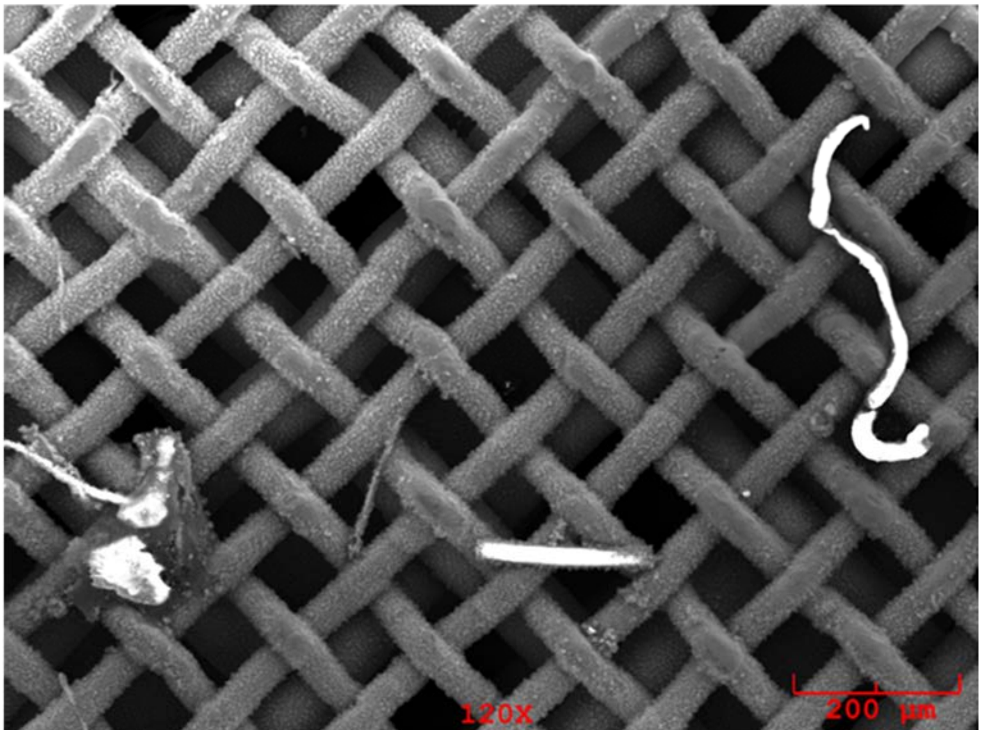


Figure P - 15 TMS Screen, Bottom, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	6.90	5.475	wt.%	0.787	1.022	
O	Ka	4.13	1.147	wt.%	0.248	0.338	
Al	Ka	2.91	0.476	wt.%	0.163	0.235	
S	Ka	55.53	5.818	wt.%	0.191	0.168	
Cr	Ka	101.07	15.404	wt.%	0.346	0.246	
Mn	Ka	4.69	0.953	wt.%	0.243	0.346	
Fe	Ka	239.87	58.269	wt.%	0.794	0.389	
Ni	Ka	15.50	5.529	wt.%	0.424	0.486	
Zn	Ka	12.88	6.929	wt.%	0.555	0.610	
			100.000	wt.%			Total

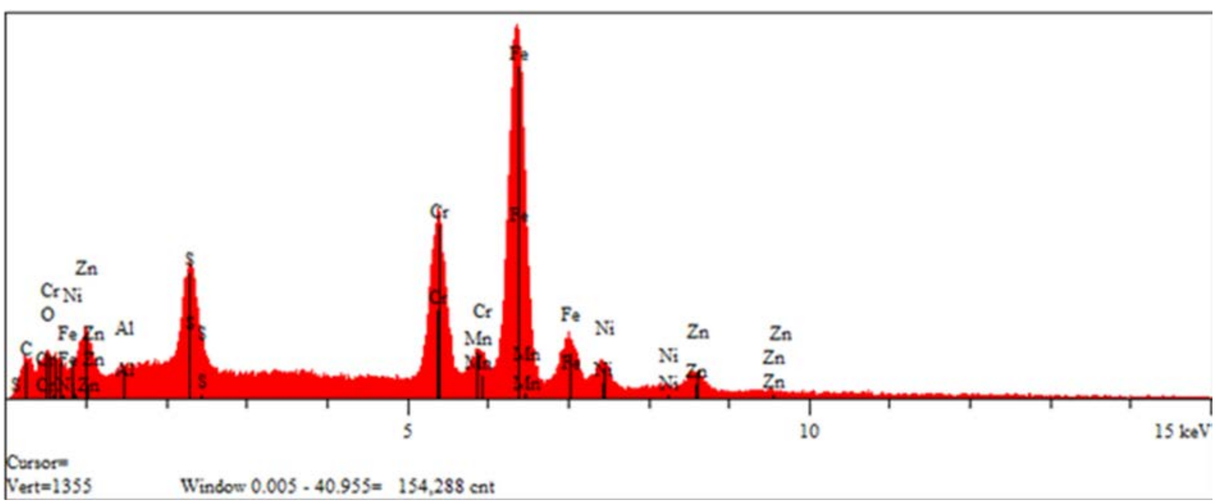


Figure P - 16 TMS Screen, Bottom, 120X and EDX Elemental Analysis

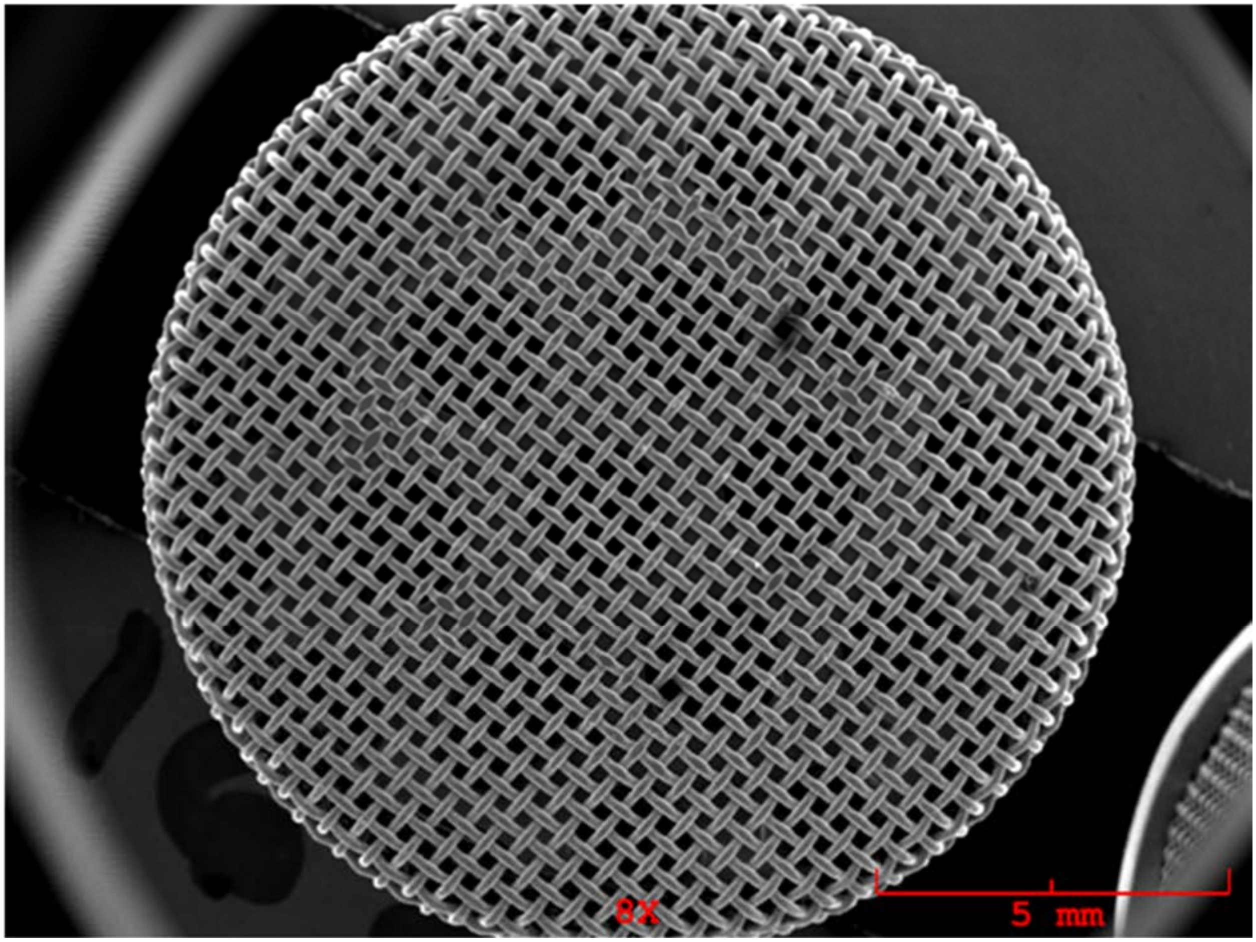
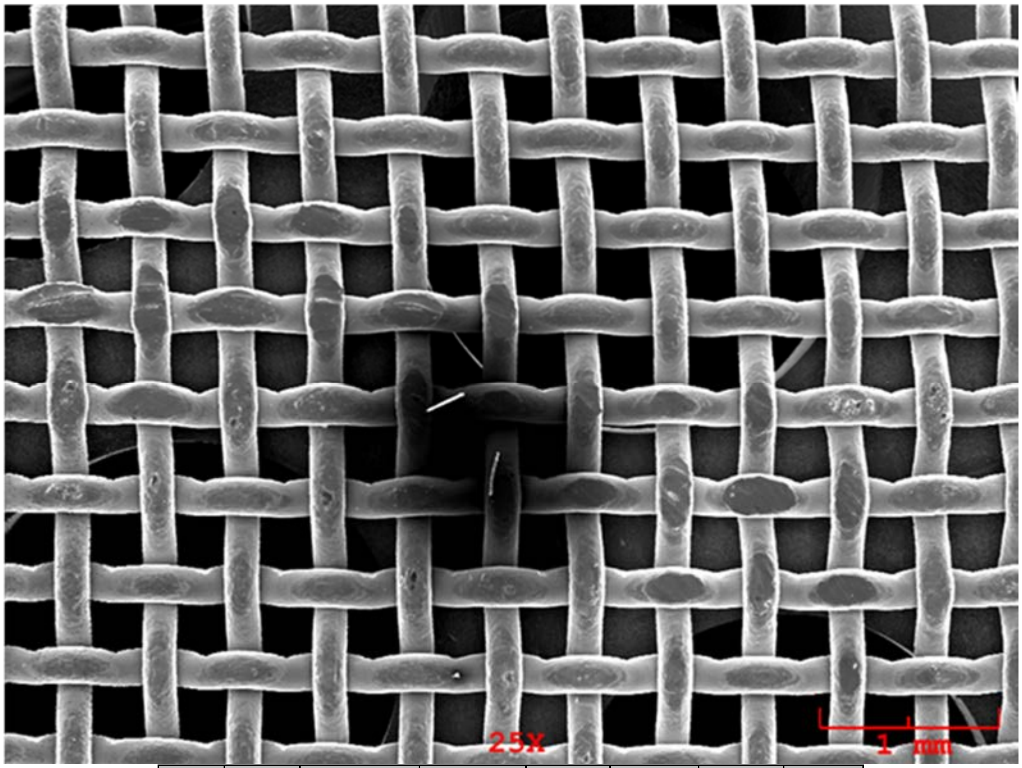


Figure P - 17 F303 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	2.03	1.252	wt.%	0.410	0.567	
Si	Ka	3.94	0.481	wt.%	0.123	0.173	
S	Ka	12.81	1.227	wt.%	0.118	0.147	
Cr	Ka	122.52	16.072	wt.%	0.320	0.206	
Mn	Ka	6.74	1.219	wt.%	0.220	0.304	
Fe	Ka	322.47	70.321	wt.%	0.817	0.355	
Ni	Ka	28.78	9.427	wt.%	0.458	0.450	
			100.000	wt.%			Total

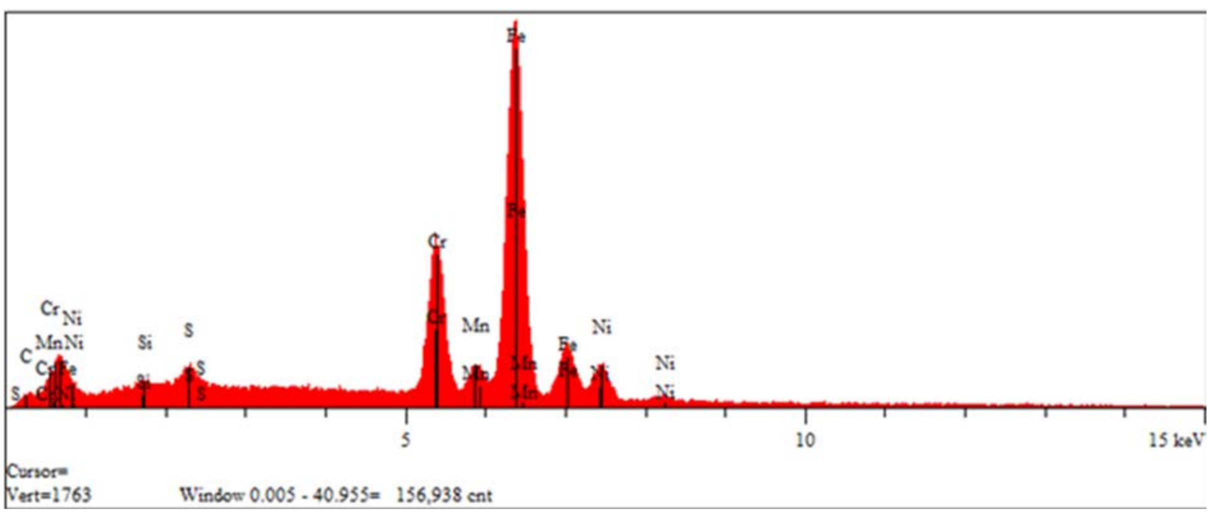


Figure P - 18 F303 Bottom 25X and EDX Elemental Analysis

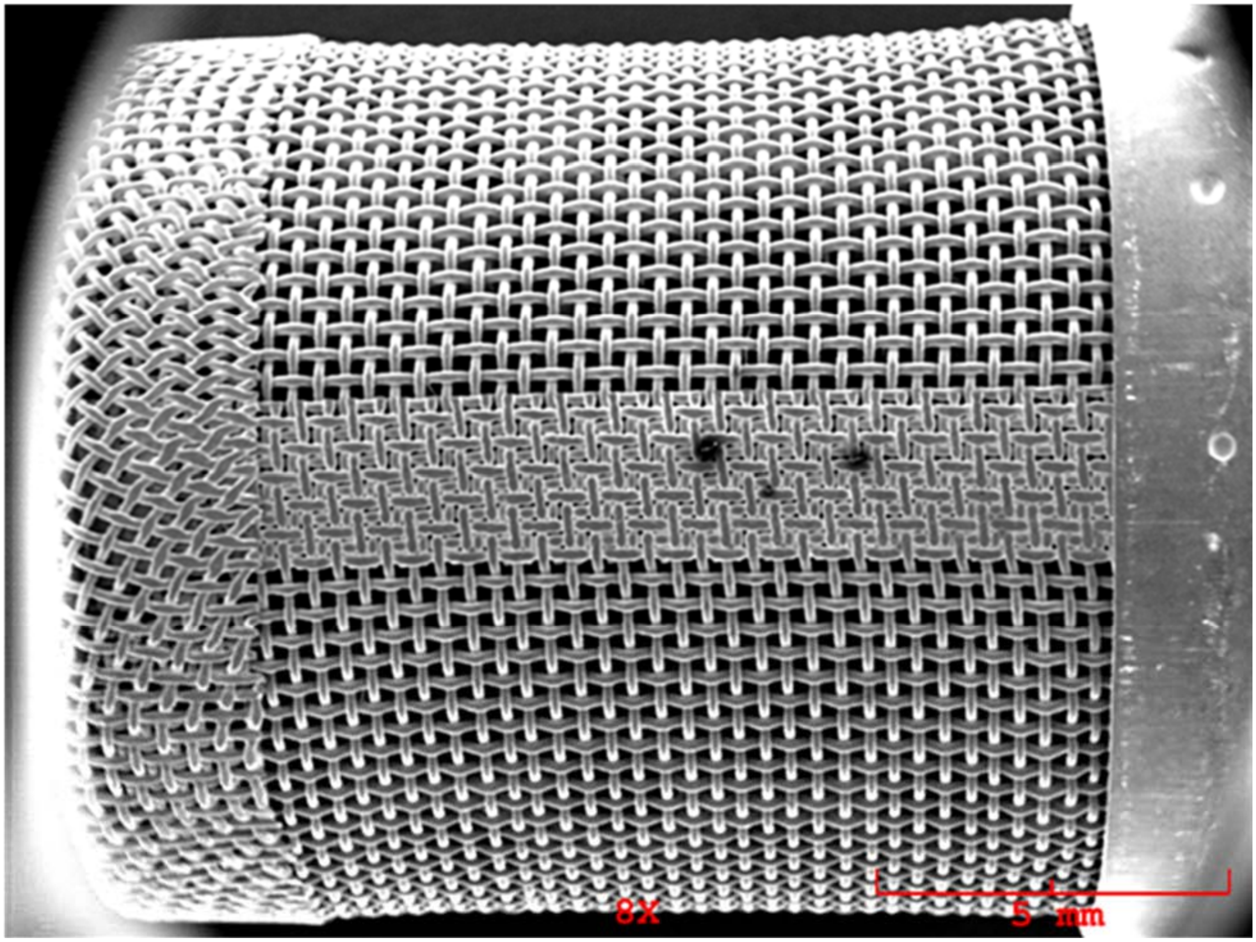
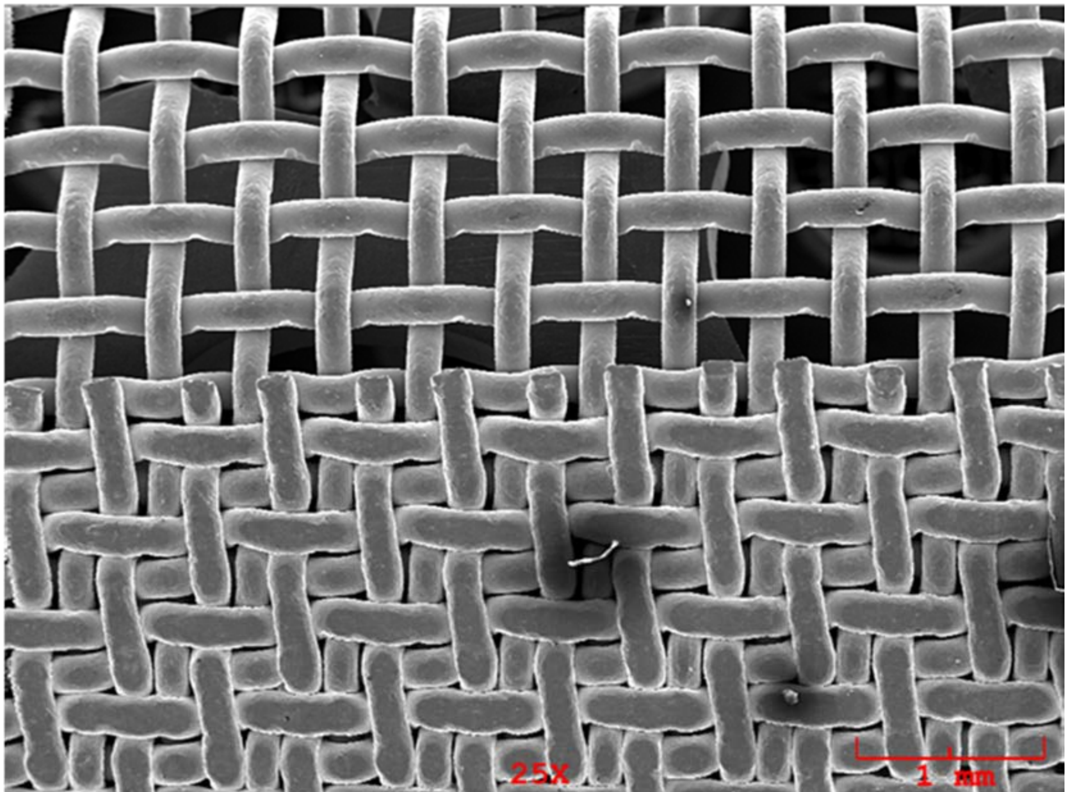


Figure P - 19 F303 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	1.95	0.961	wt.%	0.358	0.505	
Si	Ka	5.17	0.506	wt.%	0.111	0.155	
S	Ka	14.21	1.089	wt.%	0.104	0.133	
Cr	Ka	154.12	16.125	wt.%	0.287	0.188	
Mn	Ka	7.21	1.040	wt.%	0.195	0.274	
Fe	Ka	403.83	70.238	wt.%	0.729	0.315	
Ni	Ka	38.42	10.041	wt.%	0.408	0.379	
			100.000	wt.%			Total

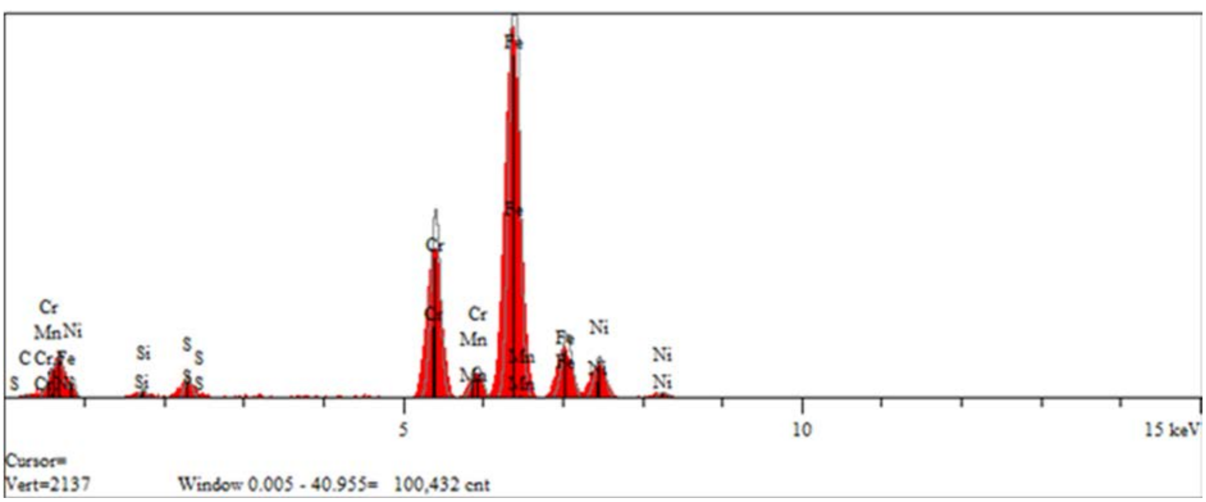


Figure P - 20 F303 Side 25X and EDX Elemental Analysis

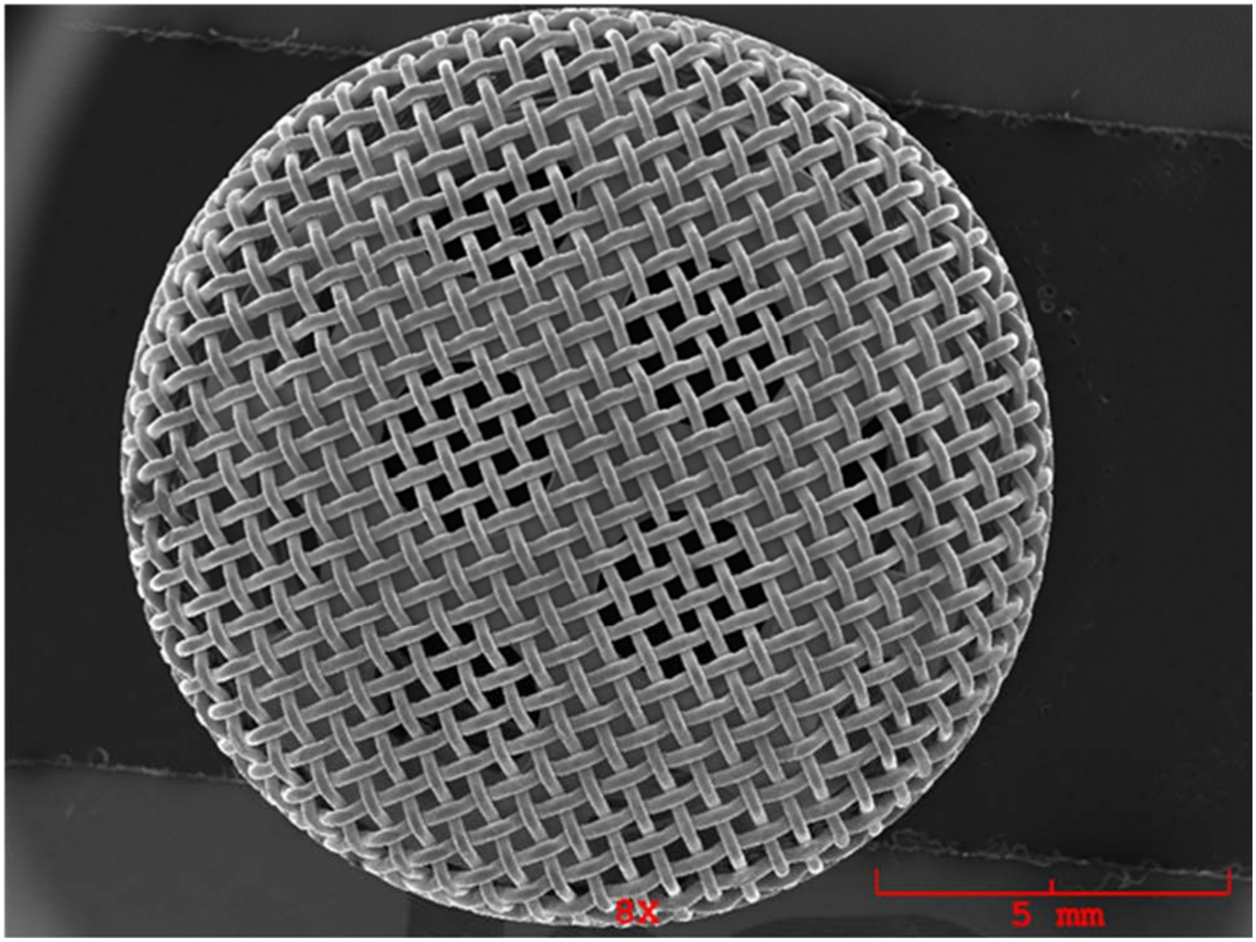
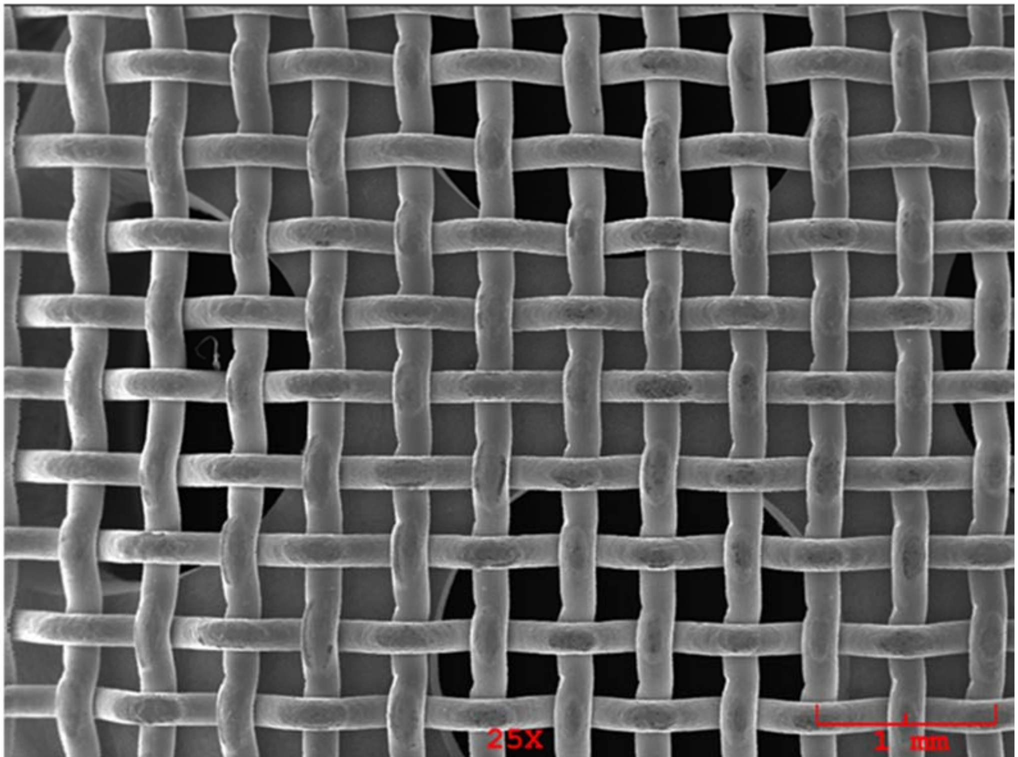


Figure P - 21 F304 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	5.18	3.267	wt.%	0.470	0.570	
S	Ka	16.21	1.594	wt.%	0.127	0.152	
Cr	Ka	114.93	15.572	wt.%	0.321	0.208	
Mn	Ka	5.30	0.992	wt.%	0.218	0.307	
Fe	Ka	306.60	69.111	wt.%	0.823	0.355	
Ni	Ka	26.96	9.119	wt.%	0.459	0.452	
Cu	Ka	0.83	0.346	wt.%	0.308	0.457	
			100.000	wt.%			Total

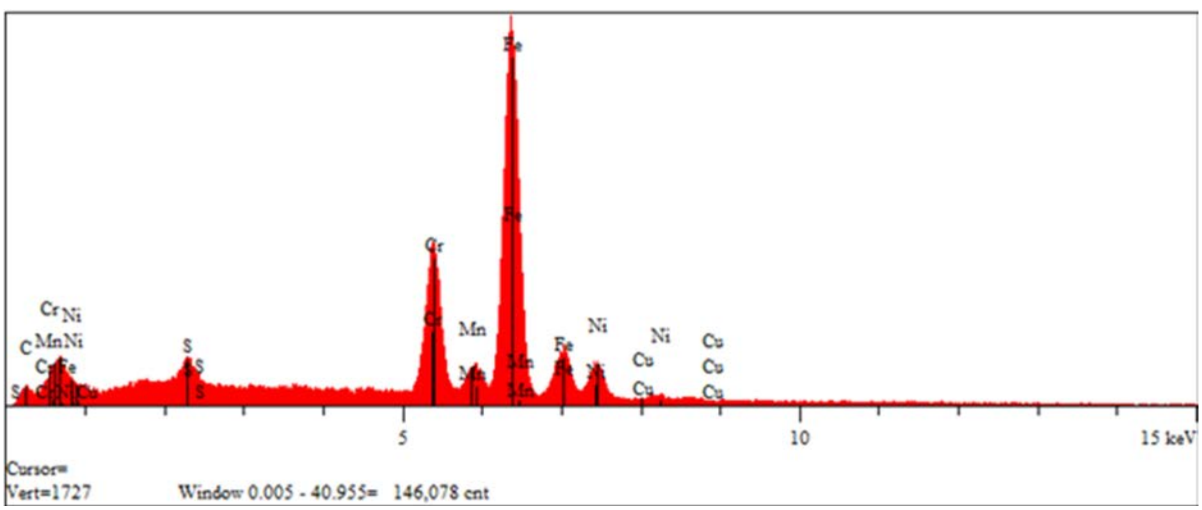


Figure P - 22 F304 Bottom, 25X and EDX Elemental Analysis

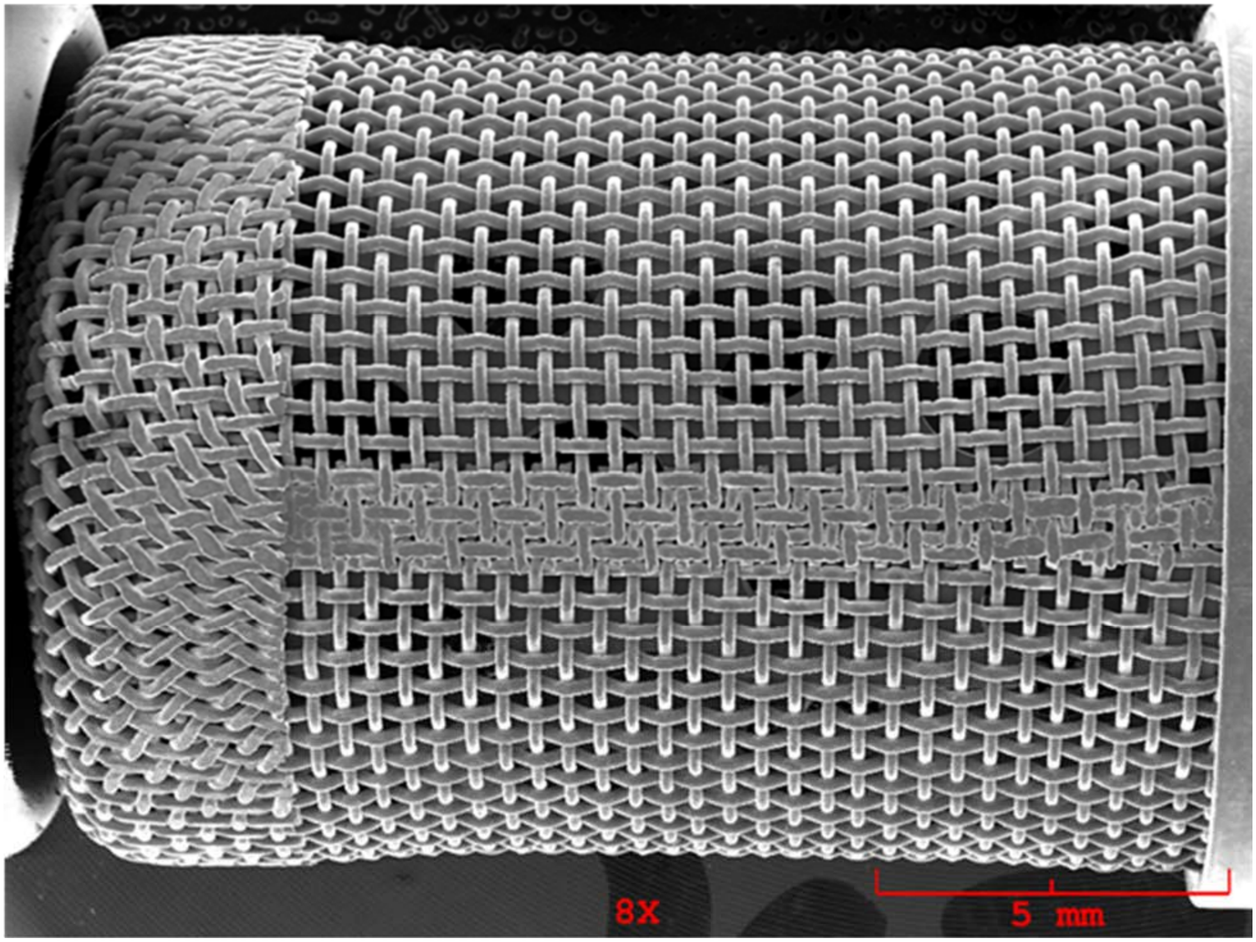
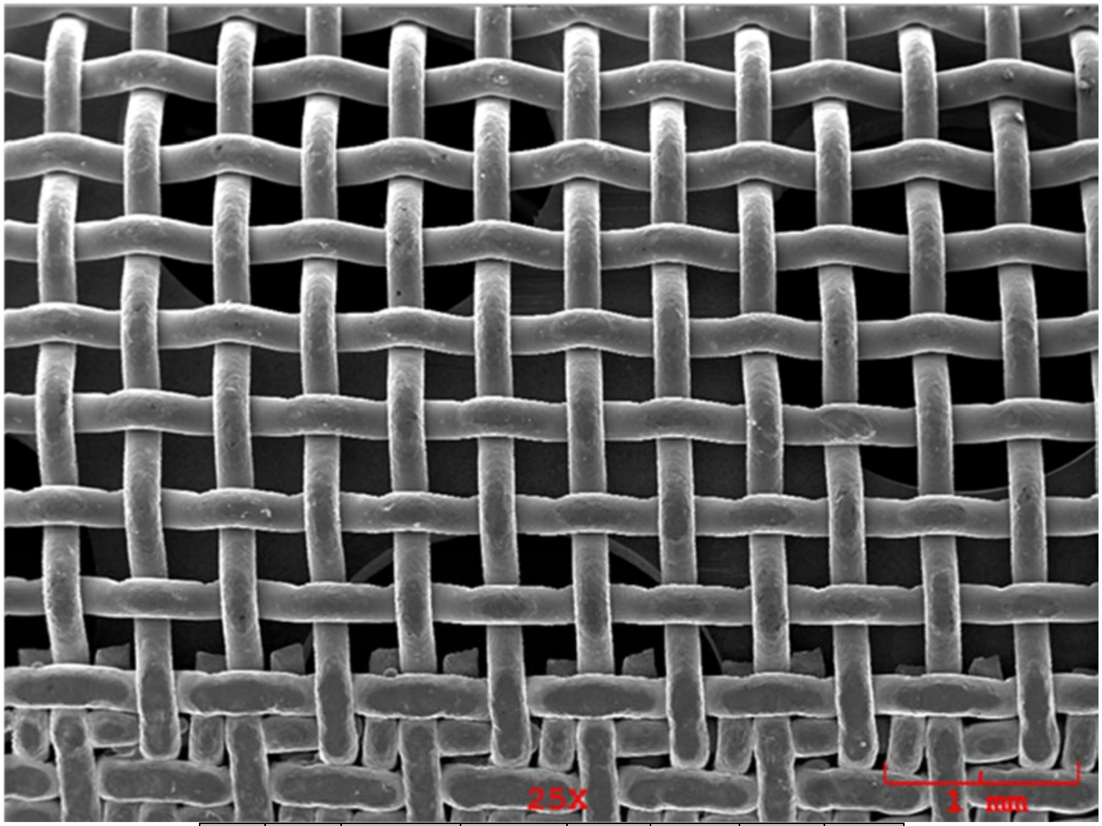


Figure P - 23 F304 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	1.94	1.076	wt.%	0.411	0.584	
Si	Ka	4.22	0.464	wt.%	0.116	0.164	
S	Ka	14.66	1.262	wt.%	0.113	0.140	
Cr	Ka	136.53	16.139	wt.%	0.302	0.188	
Mn	Ka	9.50	1.543	wt.%	0.202	0.269	
Fe	Ka	356.49	69.808	wt.%	0.767	0.313	
Ni	Ka	33.00	9.707	wt.%	0.427	0.400	
			100.000	wt.%			Total

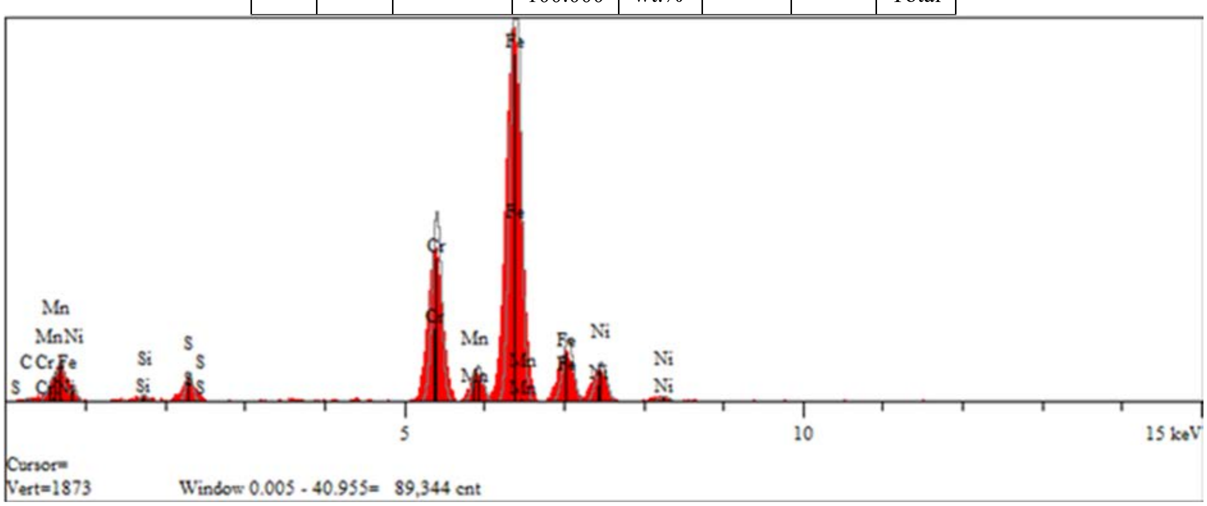


Figure P - 24 F304 Side, 25X and EDX Elemental Analysis

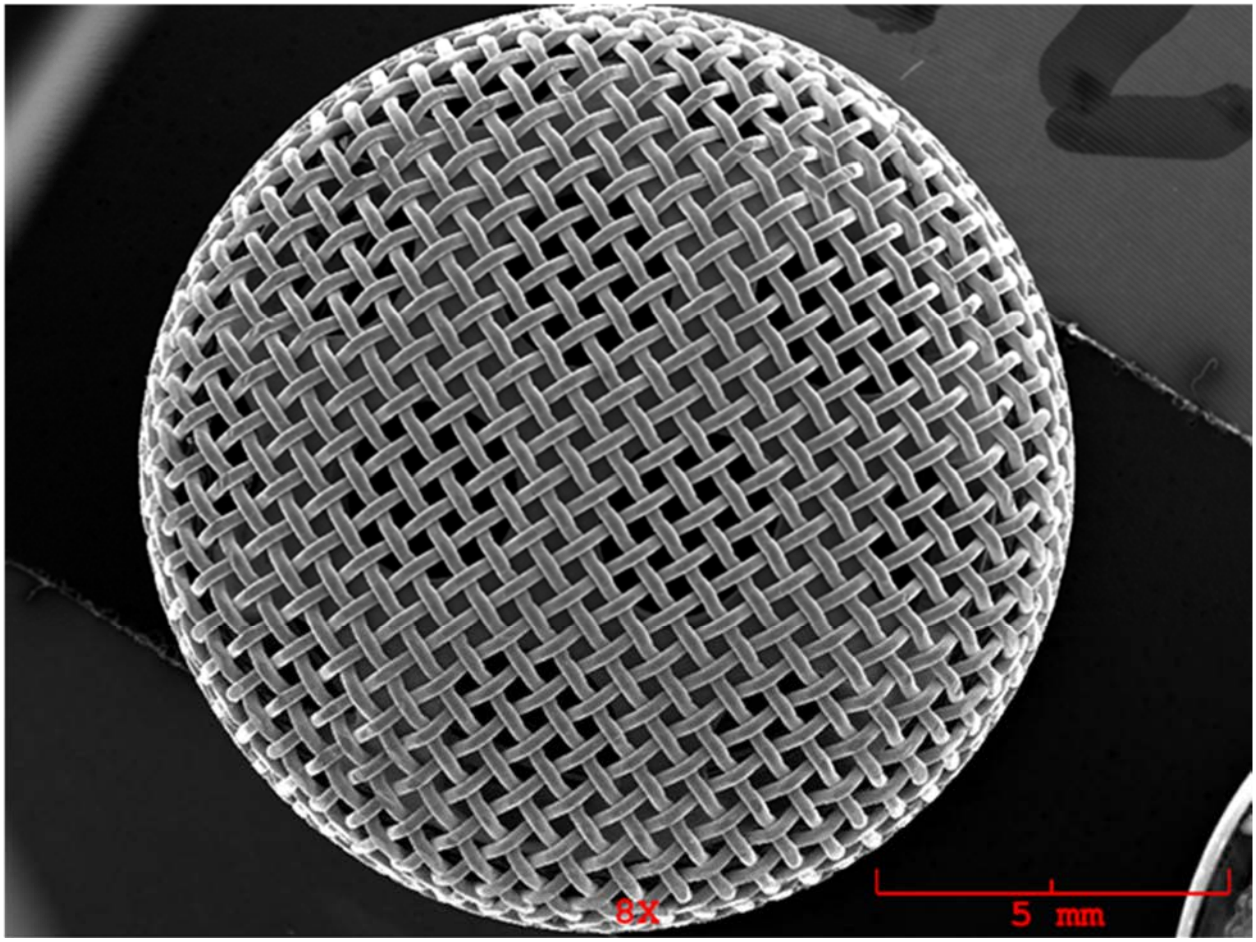
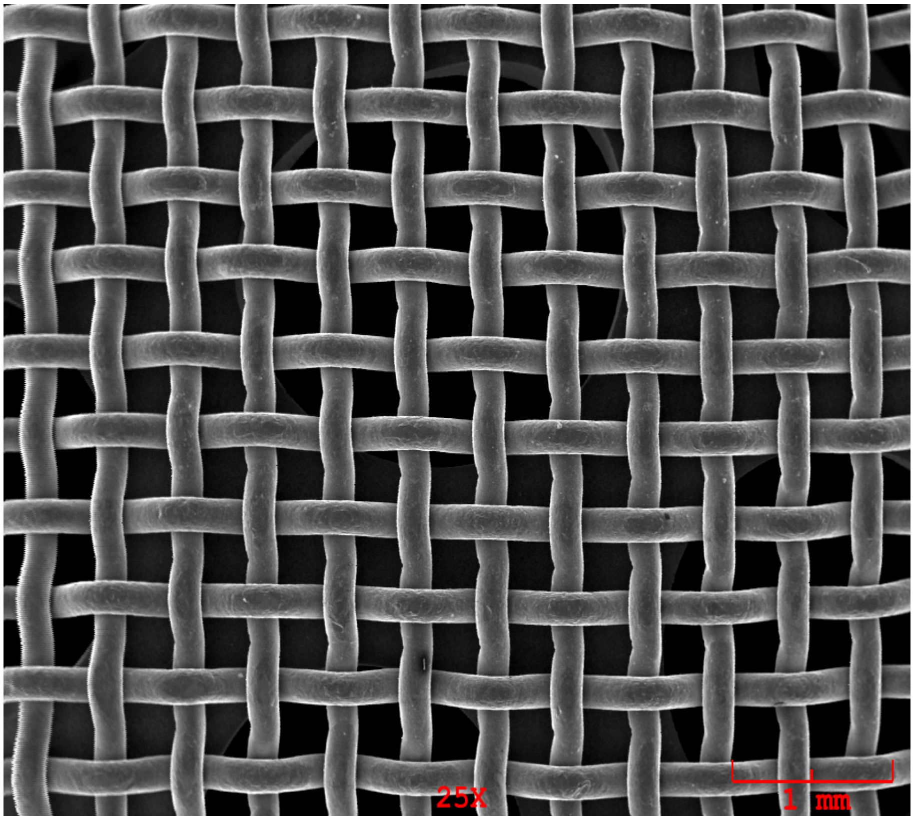


Figure P - 25 F702 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	1.53	1.007	wt.%	0.413	0.581	
Si	Ka	3.64	0.474	wt.%	0.120	0.167	
S	Ka	12.20	1.243	wt.%	0.118	0.144	
Cr	Ka	109.99	15.219	wt.%	0.320	0.207	
Mn	Ka	6.73	1.290	wt.%	0.220	0.301	
Fe	Ka	307.52	71.045	wt.%	0.842	0.351	
Ni	Ka	27.96	9.721	wt.%	0.466	0.438	
			100.000	wt.%			Total

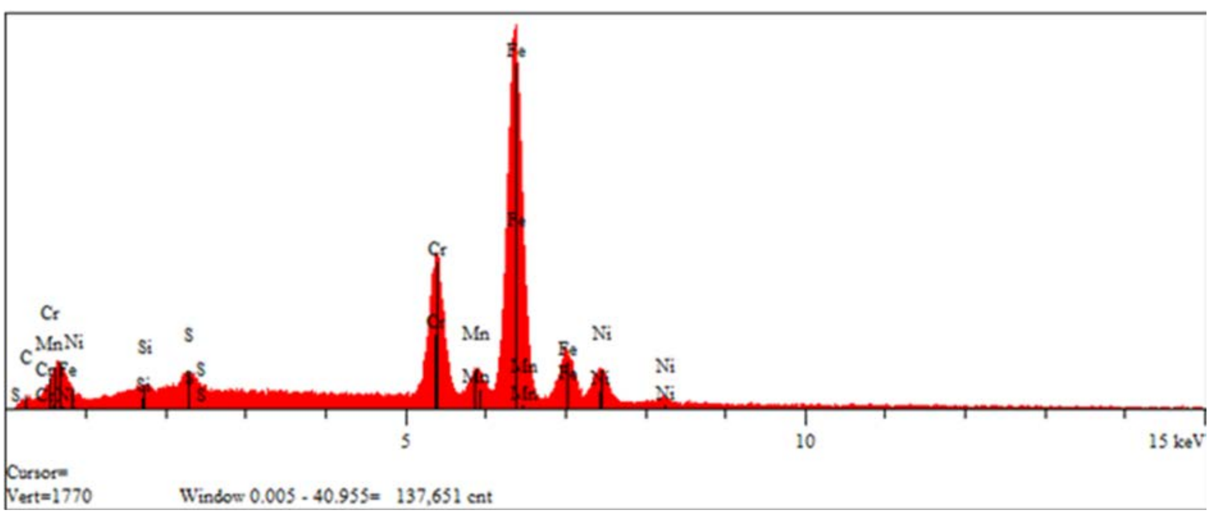


Figure P - 26 F702 Bottom, 25X and EDX Elemental Analysis

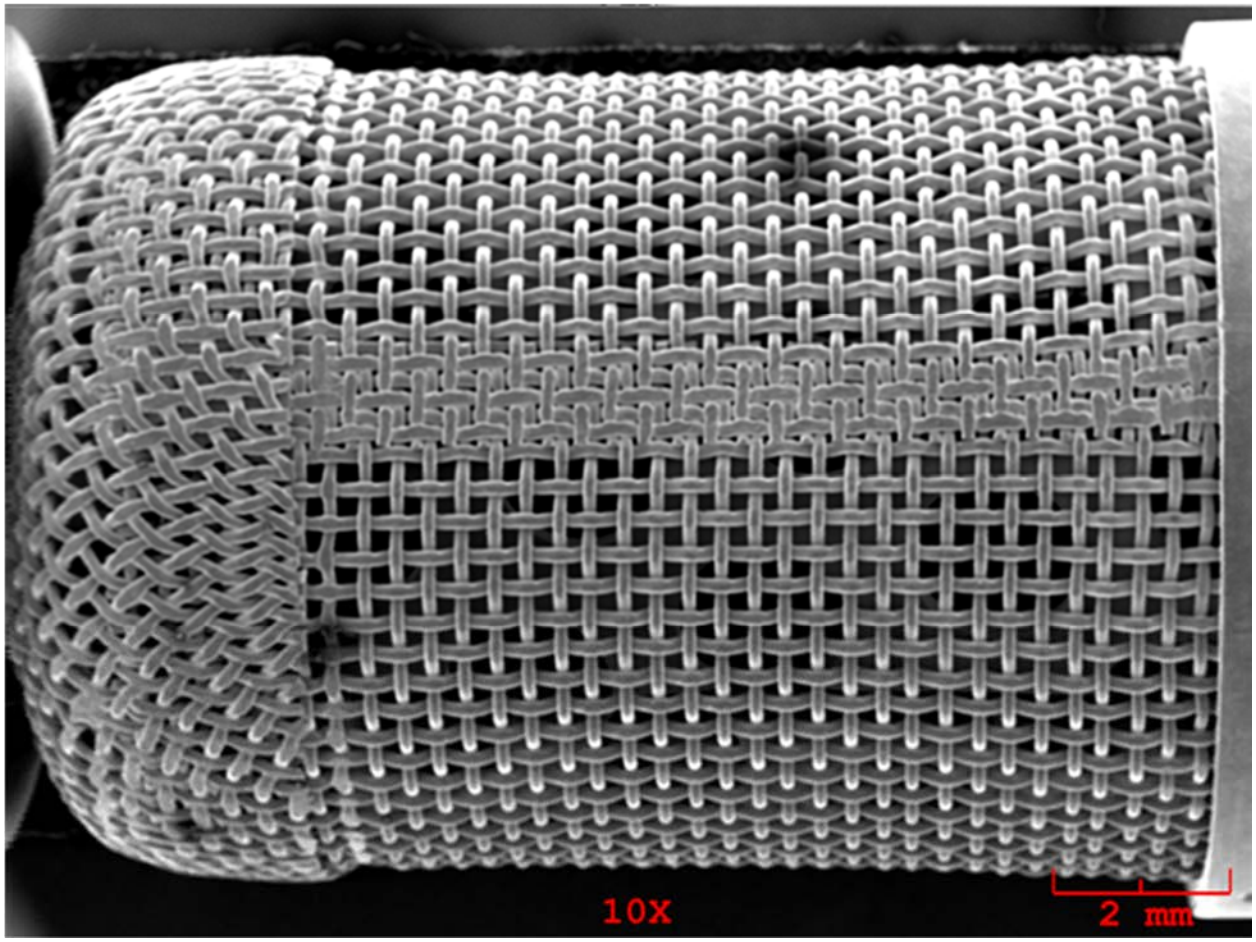
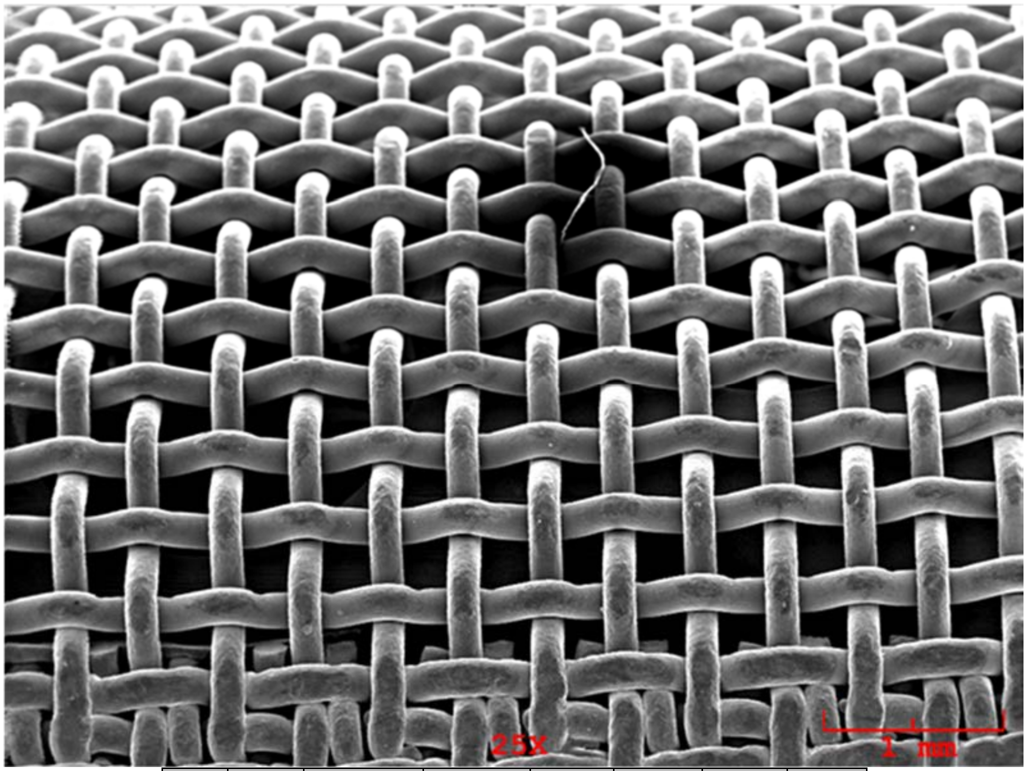


Figure P - 12 F702 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	1.53	1.007	wt.%	0.413	0.581	
Si	Ka	3.64	0.474	wt.%	0.120	0.167	
S	Ka	12.20	1.243	wt.%	0.118	0.144	
Cr	Ka	109.99	15.219	wt.%	0.320	0.207	
Mn	Ka	6.73	1.290	wt.%	0.220	0.301	
Fe	Ka	307.52	71.045	wt.%	0.842	0.351	
Ni	Ka	27.96	9.721	wt.%	0.466	0.438	
			100.000	wt.%			Total

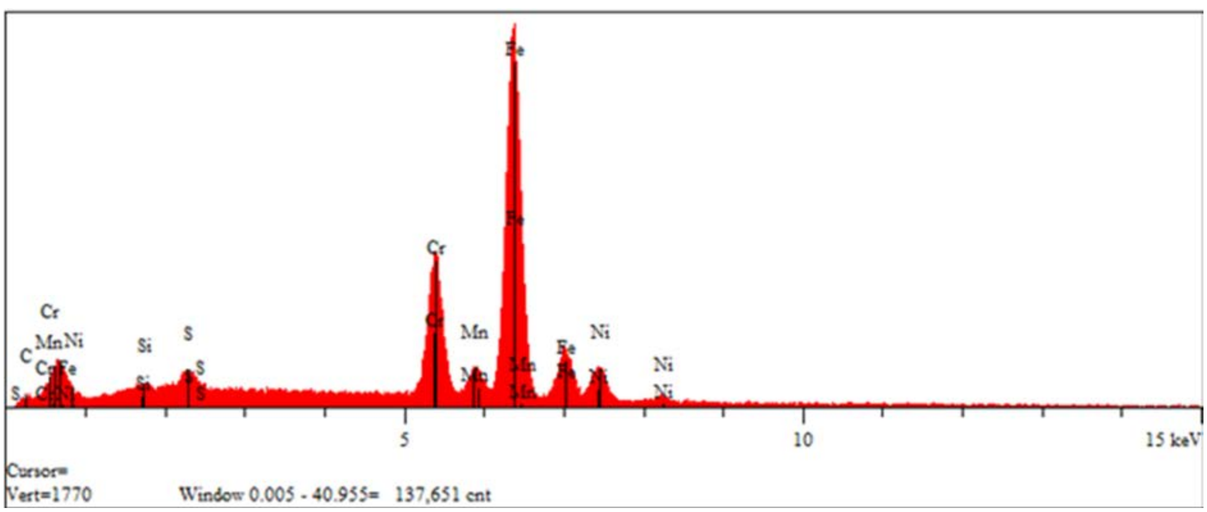


Figure P -28 F702 Side, 25X and EDX Elemental Analysis

APPENDIX Q - RUN 163 DATA PACKAGE

Run Conditions: EDTST Mode, HT Conditions
Fuel ID: POSF-12831, Gulf Coast Jet A
Airframe Heat Exchanger Bulk Fuel Output: 285 °F
HP Pump HX Out/FCOC Bulk Fuel In: 350 °F
Fuel-Cooled Oil Cooler Bulk Fuel Output: 375 °F
Burner Feed Arm Max Wetted Wall Temperature: 510 °F
Run Duration: 72 Hours

DATA SUMMARY

Run 163; Run Type: EDTST; Op Mode: HT; MSNs: N/A; EDTST Run Hours: 72 Fuel ID#: POSF12831; Run Tank: S-15; Run Type: EDTST; Op Mode: HT Fuel Type: Jet-A; Additive(s): None AFHX Out: 285 °F; FCOC In: 325 °F; FCOC Out: 375 °F; BFA MWWT: 510 °F;

Component/Device	Serial No.	Pre-Test %	Post-Test %	Spread (Pre/Post Delta), %	Shift, PPH	Skew, PSID	Flow Range Shift, PPH	Flow Midpoint Shift, PPH	Overall Rating	Hysteresis Area Change (PPH-DP)
FDV	1134	3.4	39.1	35.7	-5.4	3.8	3.7	1.9	None	305
Servo2	026	6.7	41.5	34.8	-3.7	-0.1	-0.5	-0.3	None	769

Effective Carbon - µgrams

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	126.3	130.1	136.2	82.1	62.3					
BFA	438.6	652.0	833.5	1217.0	1232.9	1474.2	1792.7	1594.0	1651.7	1546.4
Total FCOC Carbon, µgrams	537.0	µgrams	0.5	mgrams						
Total BFA Carbon, µgrams	12433.0	µgrams	12.4	mgrams						

SCREENS	Total Carbon, µg	Background Carbon, µg	Effective Carbon, µg	MWWT Start	MWWT End	Delta BFA MWWT	TE	BFA AWWT Start	BFA AWWT End	Delta BFA AWWT
TMS	246.6	0.3	246.2	510.89	488.83	-18.84	MAX	493.72	479.75	-13.98
F303	307.3	25.4	281.9	494.31	475.47	-18.84	TE325	SV Inlet	FDV Inlet	BFA Inlet
F304	181.9	12.9	169.0	497.32	475.69	-21.63	TE324	(TE702)	(TE313)	(TE316)
F305	0.0	0.0	0.0	510.89	488.83	-22.06	TE323	368	352	348
F702	2611.6	12.9	2598.7	507.21	485.22	-21.99	TE322			

Effective Carbon Deposition - µgrams/cm^2

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	34.6	35.7	37.3	22.5	17.1					
BFA	254.6	378.4	483.8	706.4	715.7	855.7	1040.6	925.2	958.7	897.6

TMS Mass Change - grams

Component/Device	Tare, g	Mass, g	Mass Gain, g
TMS	0.08660	0.08752	0.00092
F303	7.17182	7.17252	0.00070
F304	3.05532	3.05583	0.00051
F305	0.00000	0.00000	0.00000
F702	3.05514	3.05942	0.00428

Hysteresis Ratings:

• NONE: indicating that the pre-test and post-test hysteresis curves, for all intents and purposes, are nearly indistinguishable from one another. Minor differences may be seen between the pre-test and post-test curves but these are very small.

• Minor: There are small differences between per- and post-test curves. The spread for these curves is typically within 5% of one another. There may be some small changes in shift and skew for the valve. This degree of hysteresis would not be expected to alter the functional nature of the valve.

• Moderate: There are definite differences between pre-and post-test curves. There may be definite differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically between 5% and 15%. This degree of hysteresis might be expected to alter the functional nature of the valve.

• Severe: There are pronounce differences between pre-and post-test curves. There may be pronounced differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically in excess 15%. This degree of hysteresis would be considered out-of-spec for the valve.

• Non-Functional: There are major differences between pre-and post-test curves. There may be major differences in shift and skew as well. The hysteresis curve will exhibit flat segments (either vertically or horizontally). Shift and skew have majorly changed the performance envelope of the valve. This degree of hysteresis would cause the valve to be non-functional or unresponsive over small or large portions of the performance range of the valve.

Figure Q - 1 Run 157 Data Summary

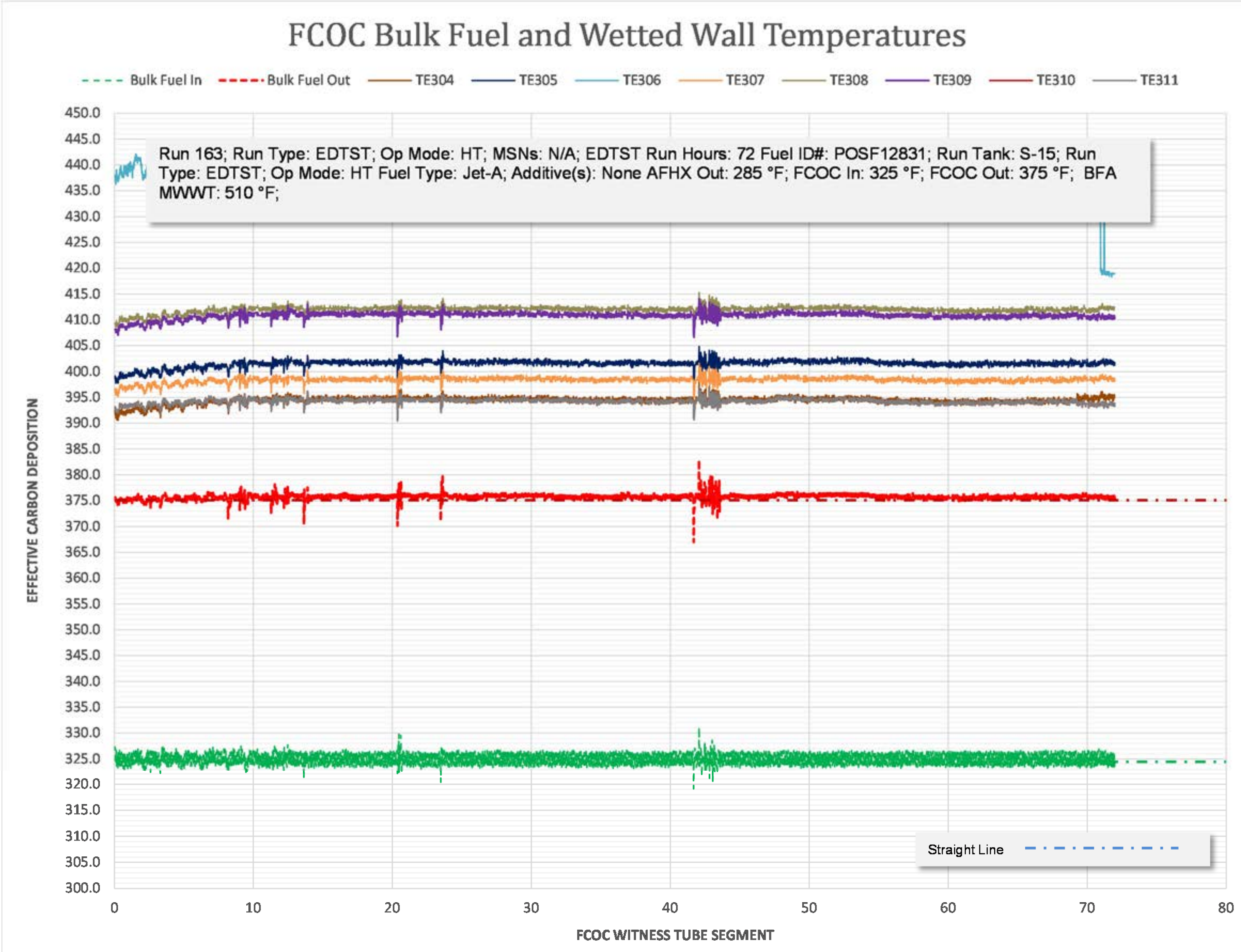


Figure Q - 2 FCOC Bulk Fuel and Wetted Wall Temperatures

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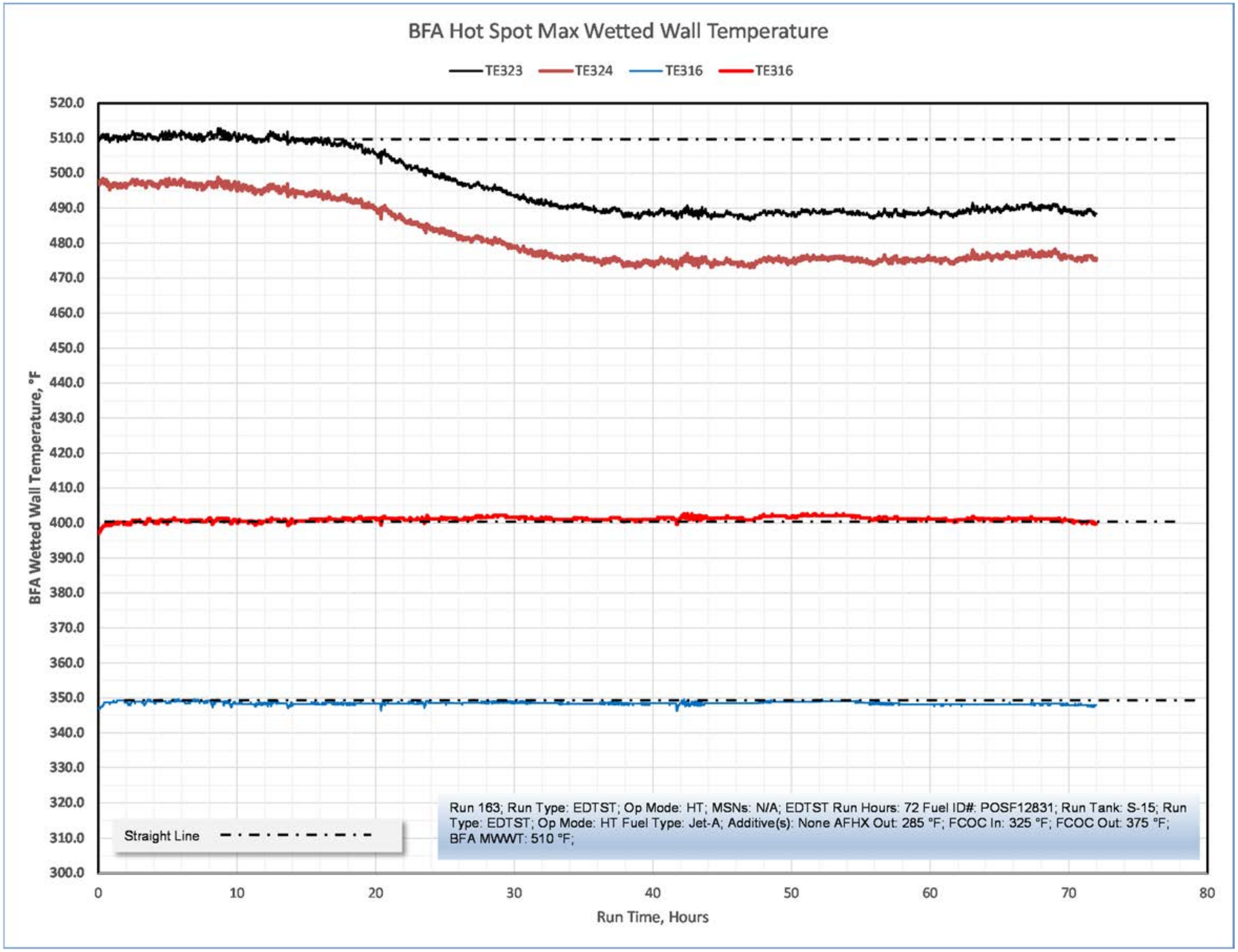


Figure Q - 3 BFA Hot Spot Max Wetted Wall And Bulk Fuel Temperatures

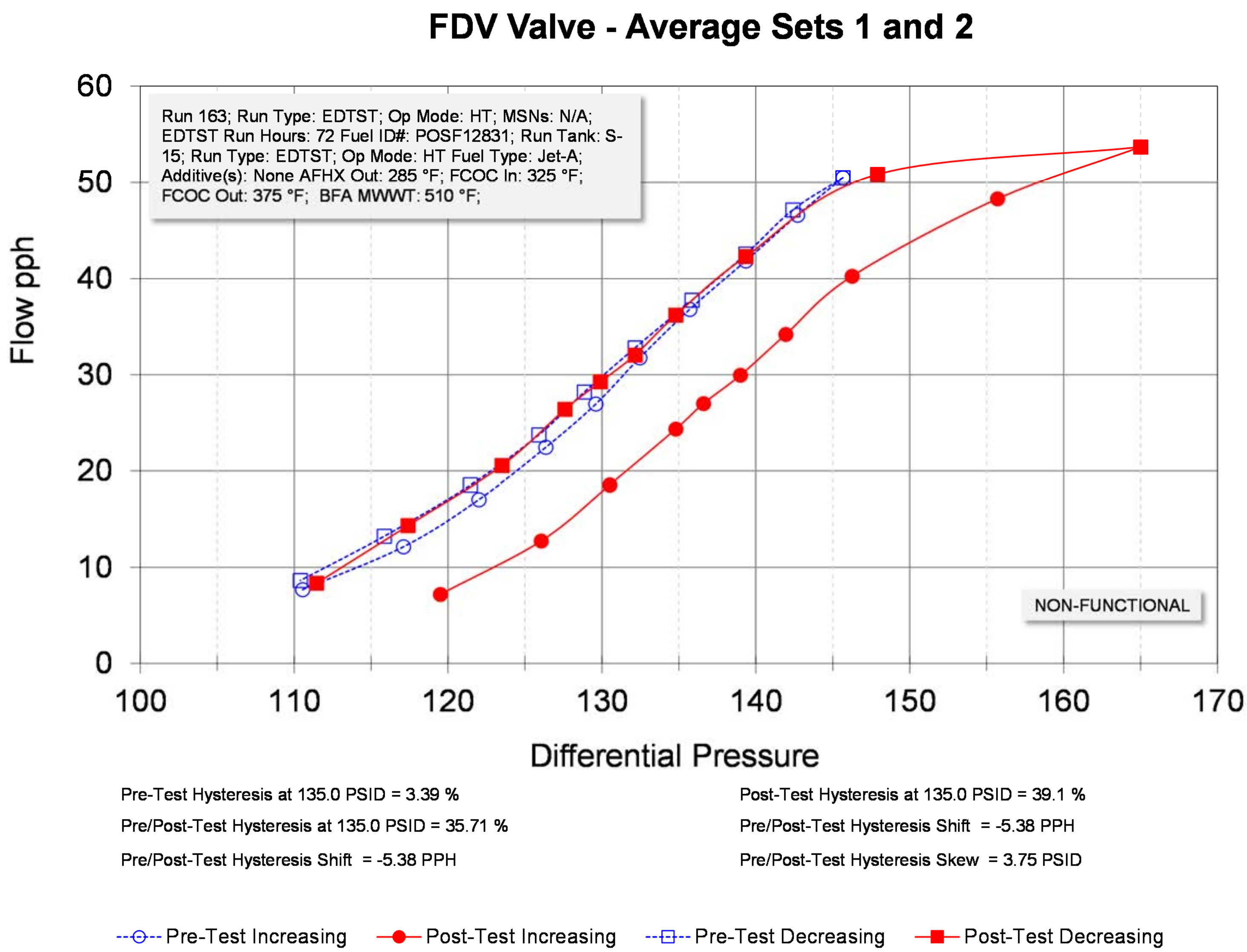


Figure Q - 4 FDV Hysteresis

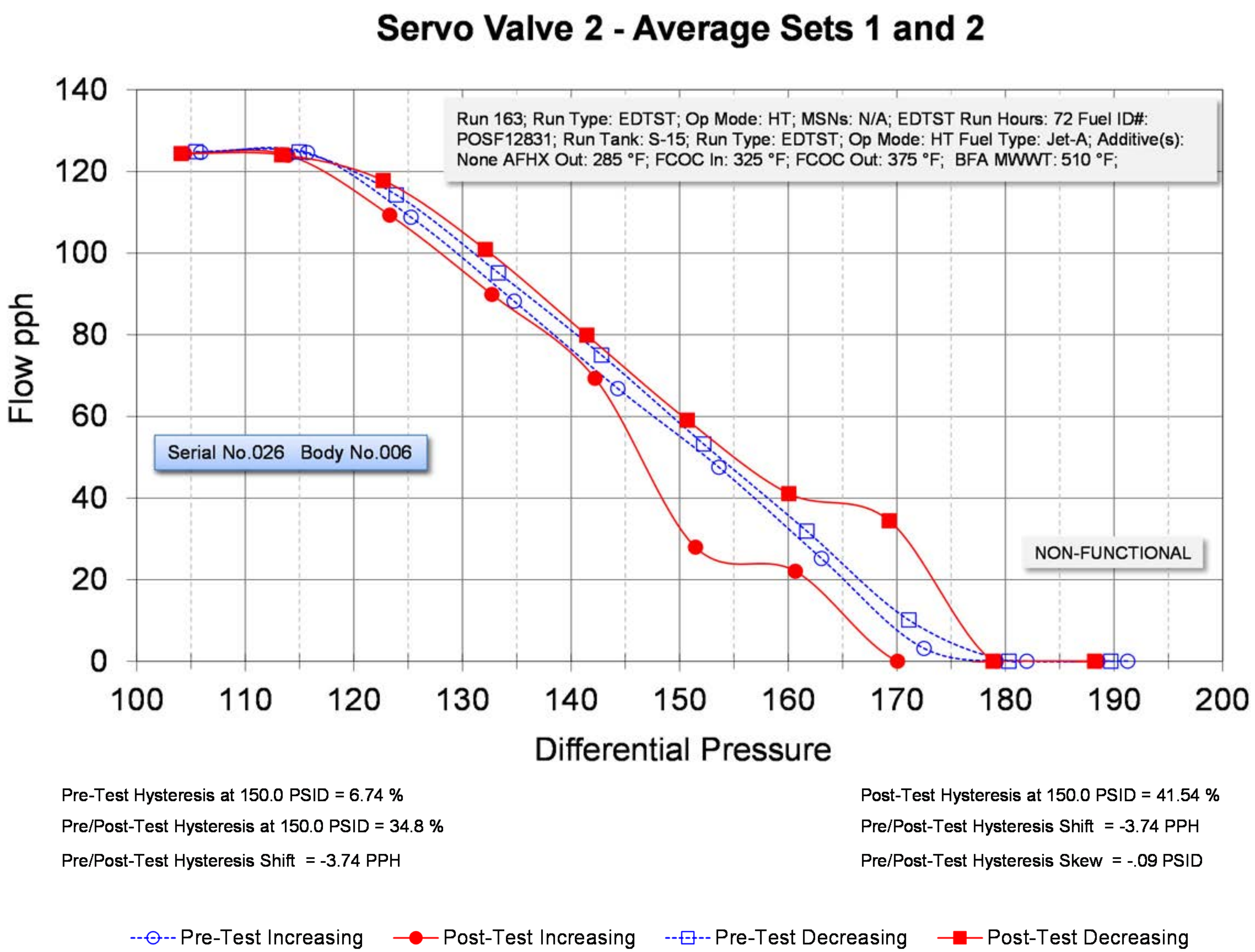


Figure Q - 5 Servo Valve Hysteresis

Figure Q - 6 FDV Components - Comparison to Clean

FDV Components Comparison to Clean
Run 163

Figure Q - 7 Servo Valve and Nozzle Screen Components - Comparison to Clean

Figure Q - 8 TMS Screen Top and Bottom - Comparison to Clean

GCxGC Results

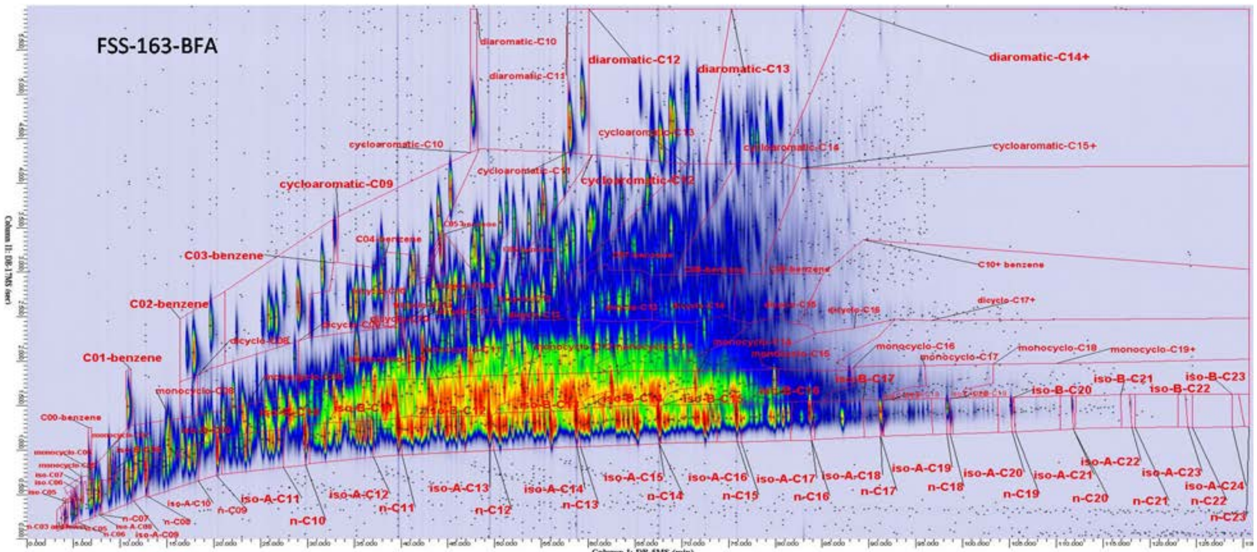


Figure Q - 9 GCxGC Summary POSF-12831 BFA Outlet

Table Q - 1 GCxGC Tabulated Data POSF-12831 Jet A Neat and Run 151 BFA Outlet

GCxGC Summary				
Hydrogen content (weight %)	13.9		13.9	
Average Molecular Wt (g/mole)	168		168	
	POSF-12831-Jet A Neat		FSS163-BFA	
	Weight %	Volume %	Weight %	Volume %
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	<0.01	<0.01
toluene (C07)	0.10	0.10	0.10	0.09
C2-benzene (C08)	0.42	0.39	0.41	0.38
C3-benzene (C09)	0.88	0.82	0.86	0.80
C4-benzene (C10)	1.47	1.37	1.51	1.41
C5-benzene (C11)	1.78	1.66	1.69	1.57
C6-benzene (C12)	1.69	1.58	1.67	1.55
C7-benzene (C13)	1.21	1.13	1.23	1.15
C8-benzene (C14)	0.99	0.92	0.98	0.92
C9-benzene (C15)	0.55	0.51	0.57	0.53
C10+-benzene (C16+)	0.24	0.23	0.23	0.22
Total Alkylbenzenes	**9.33**	8.69	**9.26**	8.62
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.11	0.08
diaromatic-C11	0.51	0.40	0.50	0.39
diaromatic-C12	0.96	0.77	0.94	0.75
diaromatic-C13	0.58	0.47	0.58	0.47
diaromatic-C14+	0.18	0.15	0.17	0.14
Total Alkylnaphthalenes	**2.33**	1.87	**2.29**	1.84
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.03	0.02	0.03	0.02
cycloaromatic-C10	0.53	0.44	0.53	0.44
cycloaromatic-C11	1.54	1.32	1.55	1.33
cycloaromatic-C12	1.67	1.45	1.56	1.36
cycloaromatic-C13	1.54	1.35	1.65	1.44
cycloaromatic-C14	0.94	0.83	0.92	0.81
cycloaromatics-C15+	0.30	0.26	0.27	0.24
Total Cycloaromatics	**6.56**	5.67	**6.52**	5.64
Total Aromatics	**18.22**	16.24	**18.06**	16.11
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.24	0.29	0.15	0.18
C08-isoparaffins	0.43	0.49	0.42	0.48
C09-isoparaffins	0.58	0.65	0.63	0.71
C10-isoparaffins	1.46	1.61	1.45	1.61
C11-isoparaffins	2.76	2.99	2.79	3.01
C12-isoparaffins	4.56	4.94	4.50	4.88
C13-isoparaffins	4.75	5.04	4.67	4.94
C14-isoparaffins	4.49	4.72	4.59	4.82
C15-isoparaffins	3.64	3.81	3.75	3.91
C16-isoparaffins	1.50	1.55	1.46	1.52
C17-isoparaffins	0.46	0.47	0.44	0.45
C18-isoparaffins	0.15	0.16	0.15	0.16
C19-isoparaffins	0.08	0.08	0.07	0.07
C20-isoparaffins	0.05	0.05	0.05	0.05
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01
Total iso-Paraffins	**25.16**	26.85	**25.12**	26.80

n-Paraffins				
n-C07 & lower	0.19	0.22	0.18	0.21
n-C08	0.38	0.43	0.35	0.40
n-C09	0.56	0.62	0.55	0.61
n-C10	1.00	1.10	1.01	1.11
n-C11	2.89	3.13	2.97	3.21
n-C12	3.11	3.32	3.15	3.37
n-C13	2.77	2.94	2.80	2.97
n-C14	2.38	2.50	2.31	2.42
n-C15	1.40	1.46	1.43	1.49
n-C16	0.34	0.36	0.36	0.38
n-C17	0.12	0.13	0.12	0.12
n-C18	0.04	0.04	0.04	0.04
n-C19	0.02	0.02	0.02	0.02
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**15.22**	16.30	**15.30**	16.38
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.49	0.51	0.53	0.55
C08-monocyclocycloparaffins	0.71	0.72	0.68	0.70
C09-monocyclocycloparaffins	1.49	1.51	1.41	1.43
C10-monocyclocycloparaffins	2.36	2.32	2.15	2.11
C11-monocyclocycloparaffins	5.59	5.63	5.41	5.44
C12-monocyclocycloparaffins	5.49	5.49	6.00	6.01
C13-monocyclocycloparaffins	5.81	5.75	5.50	5.45
C14-monocyclocycloparaffins	4.05	4.02	4.07	4.04
C15-monocyclocycloparaffins	2.58	2.55	2.55	2.53
C16-monocyclocycloparaffins	0.93	0.92	0.77	0.76
C17-monocyclocycloparaffins	0.23	0.22	0.25	0.24
C18-monocyclocycloparaffins	0.06	0.06	0.07	0.06
C19+-monocyclocycloparaffins	0.04	0.03	0.03	0.03
Total Monocycloparaffins	**29.82**	29.73	**29.42**	29.35
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.27	0.25	0.35	0.32
C10-dicycloparaffins	0.71	0.64	0.83	0.75
C11-dicycloparaffins	2.43	2.28	2.36	2.22
C12-dicycloparaffins	2.60	2.46	2.79	2.64
C13-dicycloparaffins	2.89	2.73	2.75	2.59
C14-dicycloparaffins	1.89	1.78	1.97	1.86
C15-dicycloparaffins	0.63	0.59	0.77	0.72
C16-dicycloparaffins	0.04	0.03	0.18	0.17
C17+-dicycloparaffins	0.03	0.03	0.03	0.03
Total Dicycloparaffins	**11.50**	10.81	**12.05**	11.32
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.07	0.06	0.05	0.04
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.08**	0.06	**0.05**	0.04
Total Cycloparaffins	**41.40**	40.61	**41.51**	40.71
Average Molecular Formula - C	12.1		12.1	
Average Molecular Formula - H	23.2		23.2	

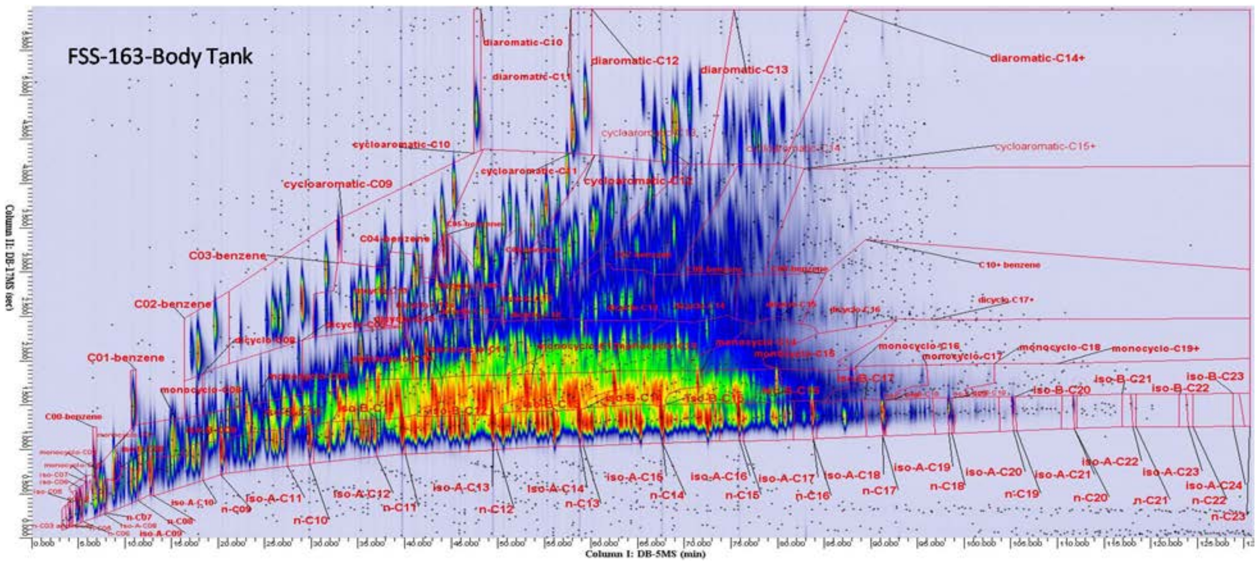


Figure Q - 10 GCxGC Summary Fuel From Body Tank

Table Q - 2 GCxGC Tabulated Data - Fuel From Body Tank at the End Of Run

GCxGC Summary				
Hydrogen content (weight %)	13.9		13.9	
Average Molecular Wt (g/mole)	168		168	
	POSF-12831-Jet A Neat		FSS163-Body Tar	
	Weight %	Volume %	Weight %	Volume %
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	0.01	0.01
toluene (C07)	0.10	0.10	0.10	0.09
C2-benzene (C08)	0.42	0.39	0.41	0.38
C3-benzene (C09)	0.88	0.82	0.86	0.80
C4-benzene (C10)	1.47	1.37	1.51	1.41
C5-benzene (C11)	1.78	1.66	1.71	1.59
C6-benzene (C12)	1.69	1.58	1.63	1.51
C7-benzene (C13)	1.21	1.13	1.20	1.12
C8-benzene (C14)	0.99	0.92	0.99	0.92
C9-benzene (C15)	0.55	0.51	0.56	0.53
C10+-benzene (C16+)	0.24	0.23	0.23	0.21
Total Alkylbenzenes	**9.33**	8.69	**9.20**	8.57
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.11	0.08
diaromatic-C11	0.51	0.40	0.50	0.39
diaromatic-C12	0.96	0.77	0.94	0.75
diaromatic-C13	0.58	0.47	0.58	0.47
diaromatic-C14+	0.18	0.15	0.16	0.13
Total Alkylnaphthalenes	**2.33**	1.87	**2.28**	1.83
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.03	0.02	0.03	0.02
cycloaromatic-C10	0.53	0.44	0.54	0.45
cycloaromatic-C11	1.54	1.32	1.53	1.31
cycloaromatic-C12	1.67	1.45	1.59	1.38
cycloaromatic-C13	1.54	1.35	1.63	1.43
cycloaromatic-C14	0.94	0.83	0.90	0.79
cycloaromatics-C15+	0.30	0.26	0.31	0.27
Total Cycloaromatics	**6.56**	5.67	**6.52**	5.64
Total Aromatics	**18.22**	**16.24**	**18.01**	**16.04**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.24	0.29	0.15	0.18
C08-isoparaffins	0.43	0.49	0.44	0.50
C09-isoparaffins	0.58	0.65	0.62	0.70
C10-isoparaffins	1.46	1.61	1.47	1.62
C11-isoparaffins	2.76	2.99	2.84	3.07
C12-isoparaffins	4.56	4.94	4.57	4.95
C13-isoparaffins	4.75	5.04	4.60	4.87
C14-isoparaffins	4.49	4.72	4.58	4.81
C15-isoparaffins	3.64	3.81	3.82	3.99
C16-isoparaffins	1.50	1.55	1.48	1.53
C17-isoparaffins	0.46	0.47	0.44	0.45
C18-isoparaffins	0.15	0.16	0.15	0.16
C19-isoparaffins	0.08	0.08	0.07	0.07
C20-isoparaffins	0.05	0.05	0.05	0.05
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01
Total iso-Paraffins	**25.16**	26.85	**25.28**	26.96

n-Paraffins				
n-C07 & lower	0.19	0.22	0.18	0.22
n-C08	0.38	0.43	0.35	0.40
n-C09	0.56	0.62	0.54	0.60
n-C10	1.00	1.10	1.02	1.12
n-C11	2.89	3.13	2.96	3.21
n-C12	3.11	3.32	3.14	3.36
n-C13	2.77	2.94	2.79	2.96
n-C14	2.38	2.50	2.45	2.57
n-C15	1.40	1.46	1.43	1.49
n-C16	0.34	0.36	0.36	0.37
n-C17	0.12	0.13	0.12	0.12
n-C18	0.04	0.04	0.04	0.04
n-C19	0.02	0.02	0.02	0.02
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**15.22**	16.30	**15.41**	16.49
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.49	0.51	0.52	0.54
C08-monocyclocycloparaffins	0.71	0.72	0.68	0.70
C09-monocyclocycloparaffins	1.49	1.51	1.45	1.46
C10-monocyclocycloparaffins	2.36	2.32	2.18	2.13
C11-monocyclocycloparaffins	5.59	5.63	5.43	5.47
C12-monocyclocycloparaffins	5.49	5.49	6.05	6.06
C13-monocyclocycloparaffins	5.81	5.75	5.61	5.55
C14-monocyclocycloparaffins	4.05	4.02	3.90	3.87
C15-monocyclocycloparaffins	2.58	2.55	2.60	2.57
C16-monocyclocycloparaffins	0.93	0.92	0.75	0.74
C17-monocyclocycloparaffins	0.23	0.22	0.25	0.25
C18-monocyclocycloparaffins	0.06	0.06	0.06	0.06
C19+-monocyclocycloparaffins	0.04	0.03	0.03	0.03
Total Monocycloparaffins	**29.82**	29.73	**29.53**	29.45
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.27	0.25	0.31	0.29
C10-dicycloparaffins	0.71	0.64	0.82	0.74
C11-dicycloparaffins	2.43	2.28	2.20	2.07
C12-dicycloparaffins	2.60	2.46	2.79	2.64
C13-dicycloparaffins	2.89	2.73	2.95	2.79
C14-dicycloparaffins	1.89	1.78	1.77	1.67
C15-dicycloparaffins	0.63	0.59	0.64	0.61
C16-dicycloparaffins	0.04	0.03	0.18	0.17
C17+-dicycloparaffins	0.03	0.03	0.03	0.02
Total Dicycloparaffins	**11.50**	10.81	**11.72**	11.01
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.07	0.06	0.06	0.05
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.08**	0.06	**0.06**	0.05
Total Cycloparaffins	**41.40**	40.61	**41.31**	40.50
Average Molecular Formula - C	12.1		12.1	
Average Molecular Formula - H	23.2		23.2	

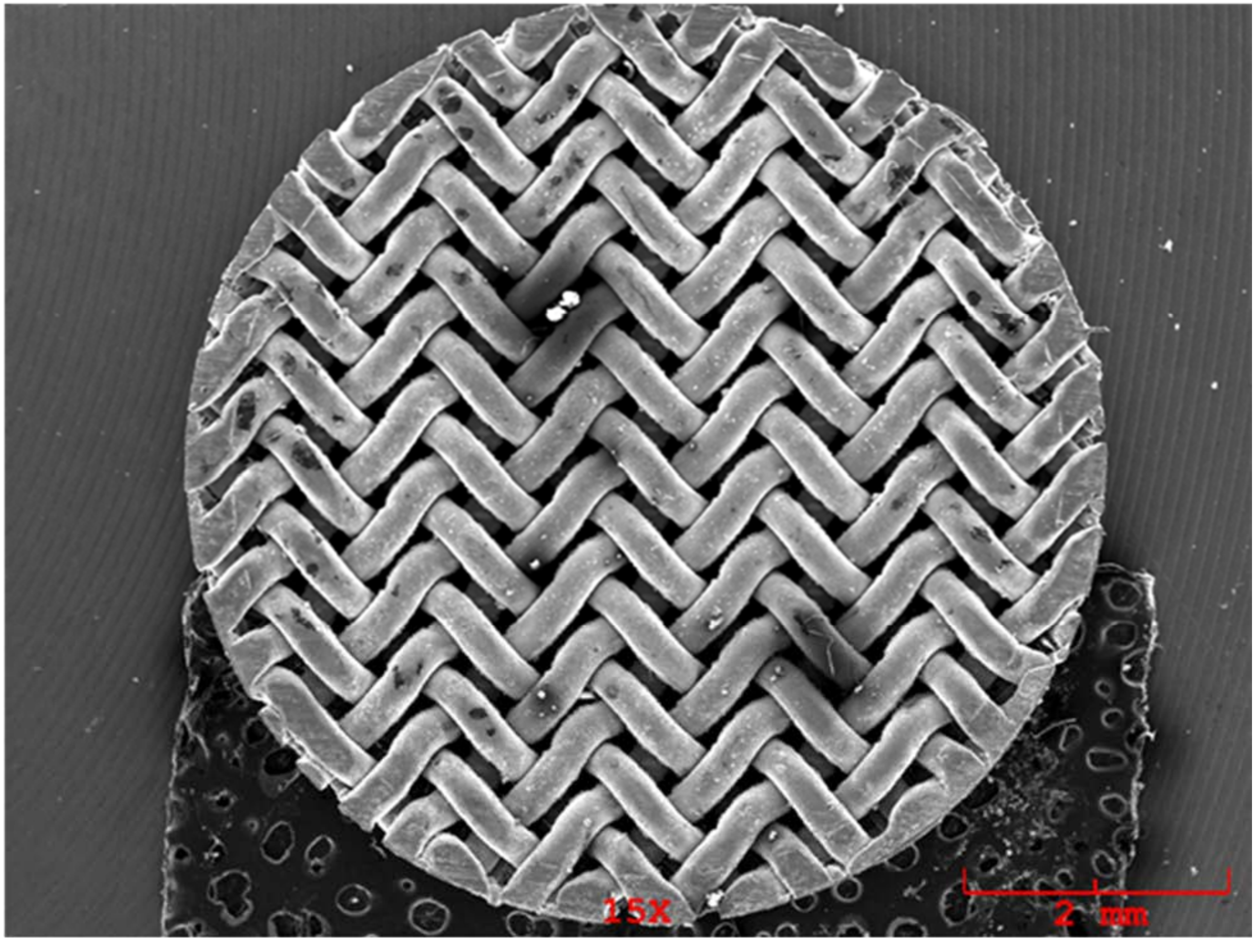
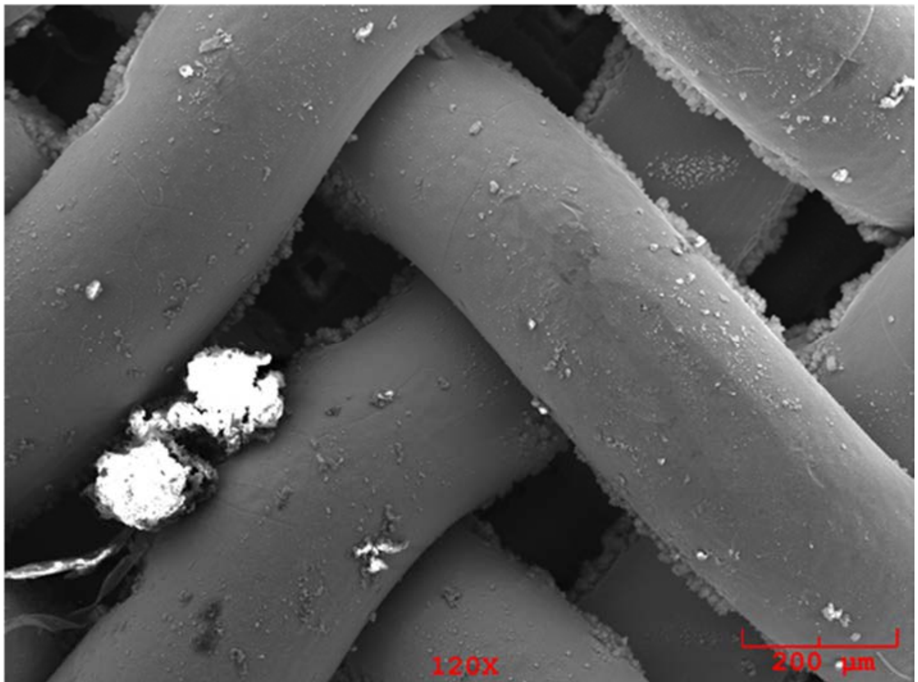


Figure Q - 11 TMS Screen, Top, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	8.88	4.908	wt.%	0.508	0.592	
Al	Ka	6.70	0.863	wt.%	0.138	0.184	
Si	Ka	6.70	0.699	wt.%	0.116	0.158	
S	Ka	27.55	2.267	wt.%	0.124	0.137	
Ca	Ka	6.07	0.501	wt.%	0.095	0.131	
Cr	Ka	135.18	15.781	wt.%	0.295	0.176	
Mn	Ka	7.15	1.121	wt.%	0.189	0.259	
Fe	Ka	324.16	60.909	wt.%	0.705	0.306	
Ni	Ka	26.48	7.404	wt.%	0.381	0.383	
Cu	Ka	16.03	5.548	wt.%	0.390	0.421	
			100.000	wt.%			Total

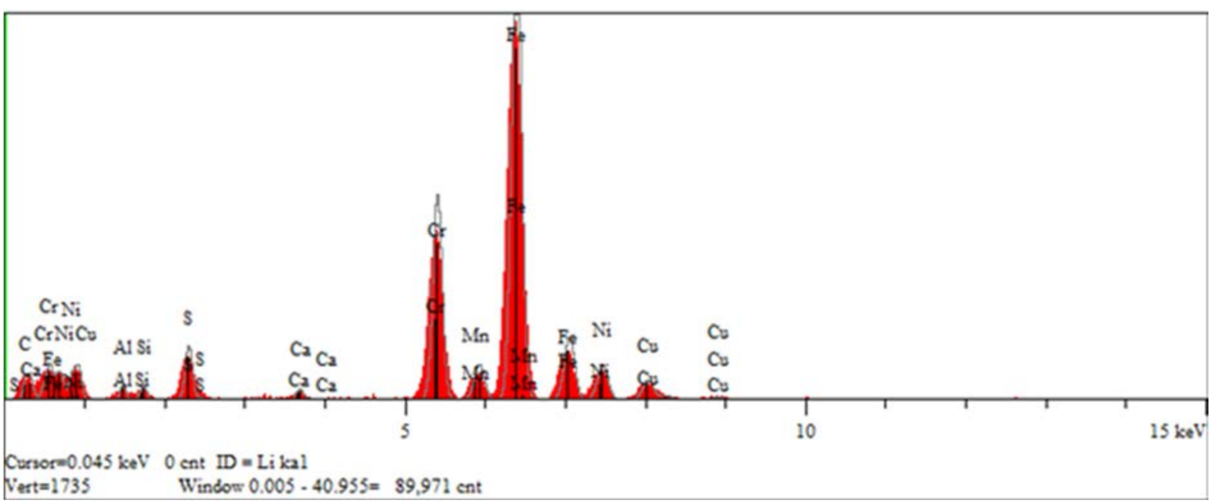


Figure Q - 12TMS Screen Top, 120X and EDX Elemental Analysis

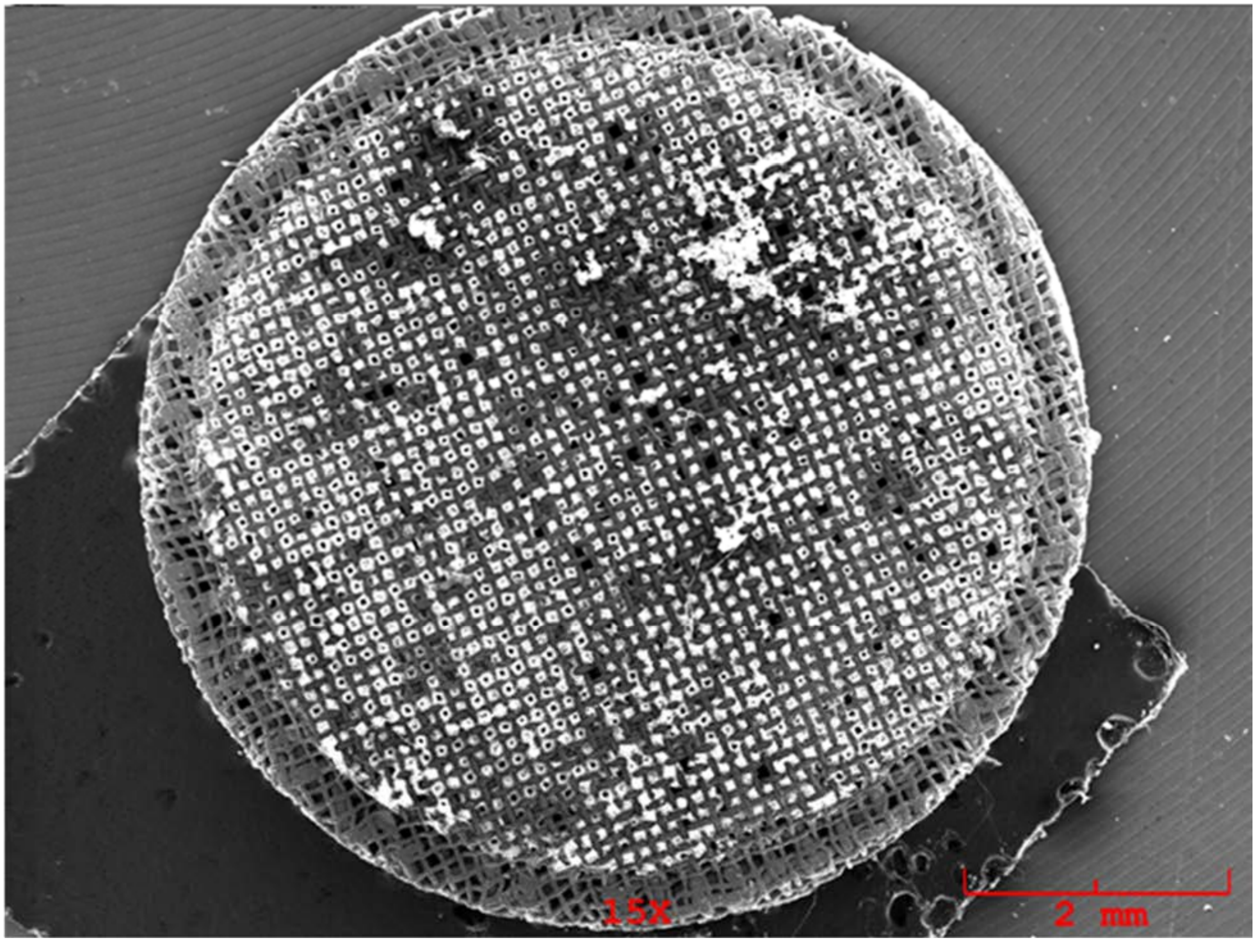
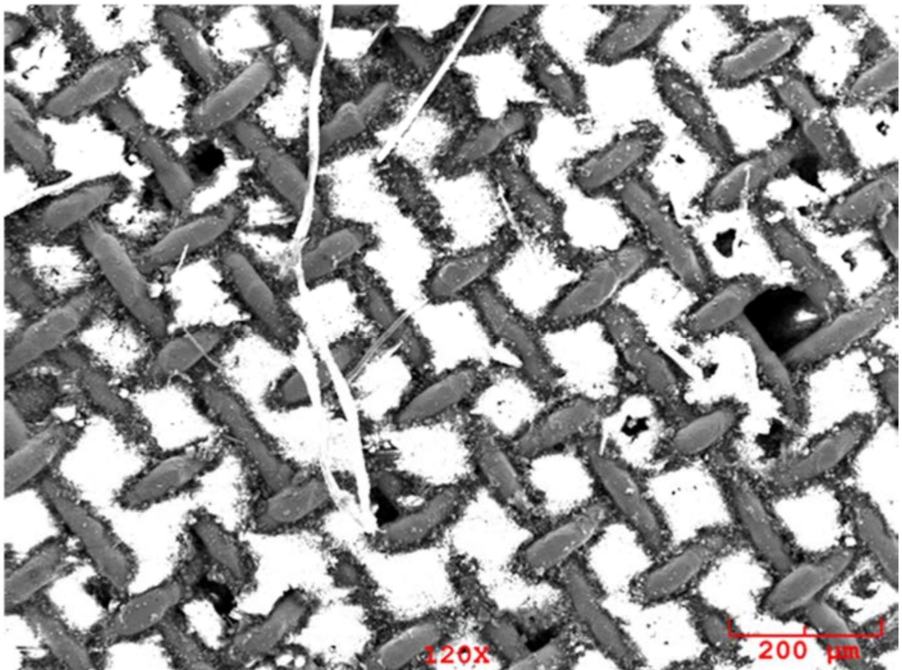


Figure Q - 13 TMS Screen, Bottom, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	14.90	12.268	wt.%	0.980	1.142	
O	Ka	7.49	2.950	wt.%	0.384	0.487	
Si	Ka	41.22	5.304	wt.%	0.231	0.246	
S	Ka	43.70	4.760	wt.%	0.199	0.211	
K	Ka	9.15	1.025	wt.%	0.139	0.187	
Ca	Ka	36.69	4.248	wt.%	0.187	0.189	
Cr	Ka	65.35	11.082	wt.%	0.319	0.249	
Mn	Ka	3.52	0.766	wt.%	0.228	0.326	
Fe	Ka	170.46	43.493	wt.%	0.710	0.377	
Ni	Ka	10.96	4.086	wt.%	0.391	0.464	
Cu	Ka	21.57	10.017	wt.%	0.554	0.532	
			100.000	wt.%			Total

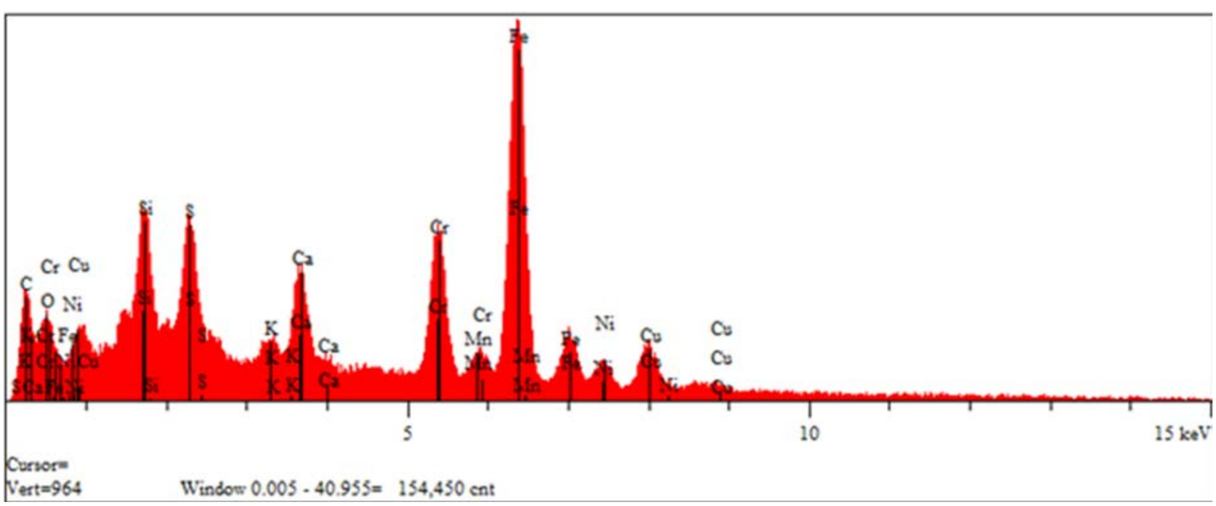


Figure Q- 14 TMS Screen, Bottom, 120X and EDX Elemental Analysis

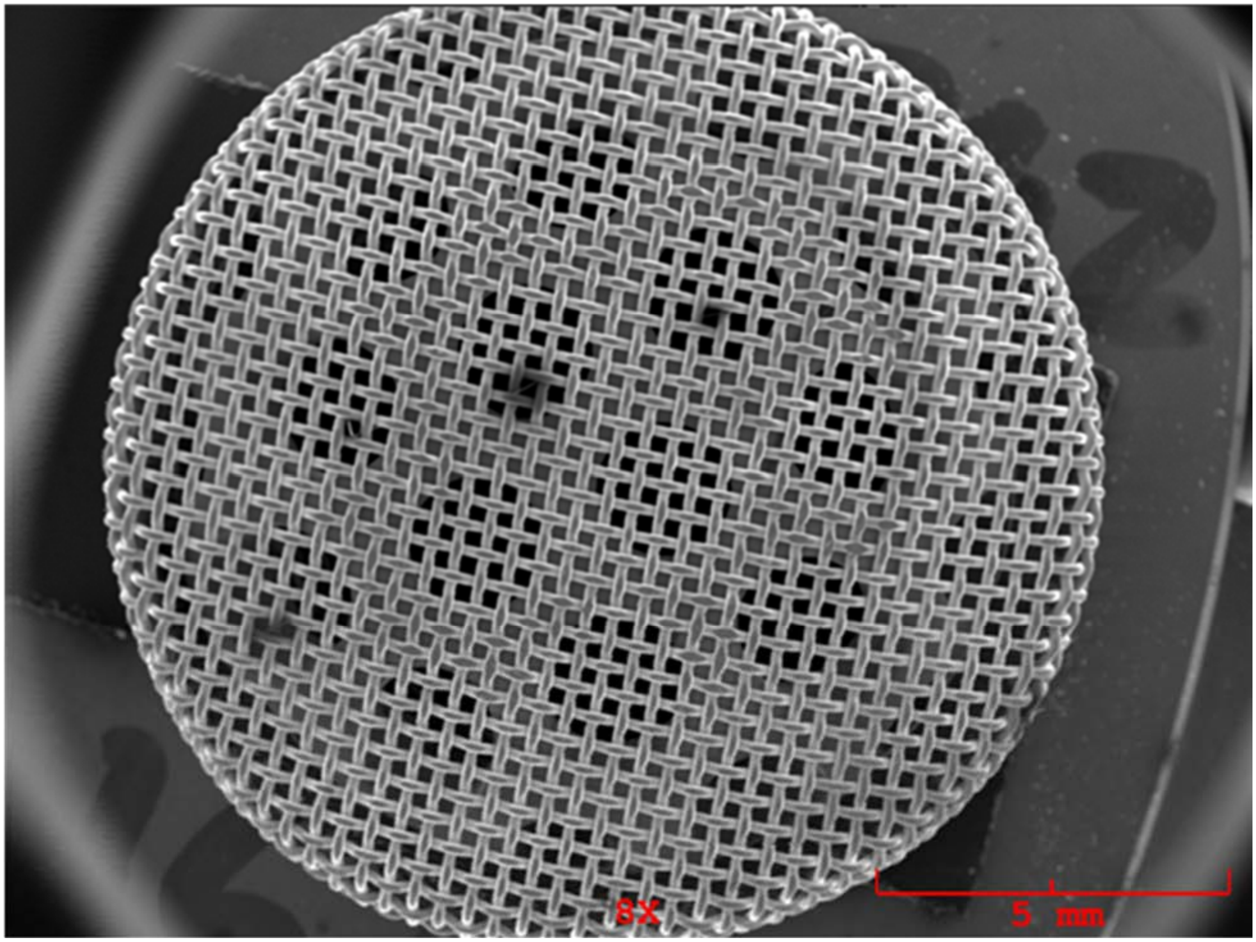
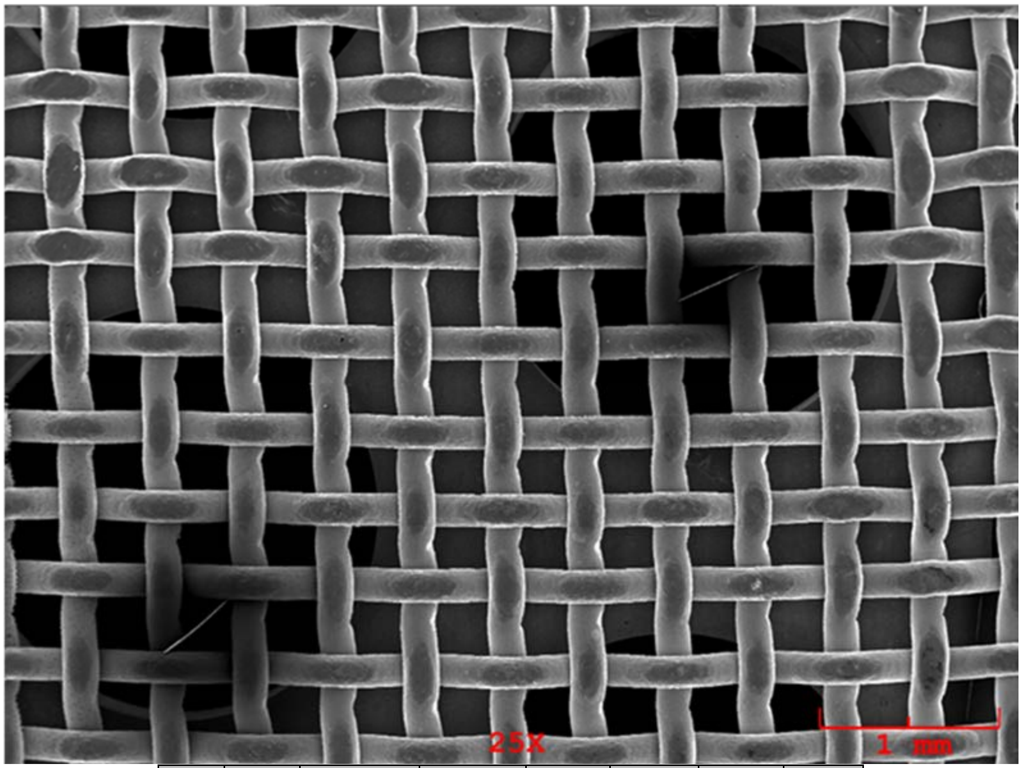


Figure Q - 15 F303 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	3.35	2.255	wt.%	0.551	0.754	
Si	Ka	3.31	0.441	wt.%	0.132	0.188	
S	Ka	12.79	1.338	wt.%	0.129	0.160	
Cr	Ka	109.76	15.747	wt.%	0.335	0.226	
Mn	Ka	4.97	0.985	wt.%	0.239	0.340	
Fe	Ka	291.52	69.551	wt.%	0.856	0.404	
Ni	Ka	27.03	9.683	wt.%	0.477	0.455	
			100.000	wt.%			Total

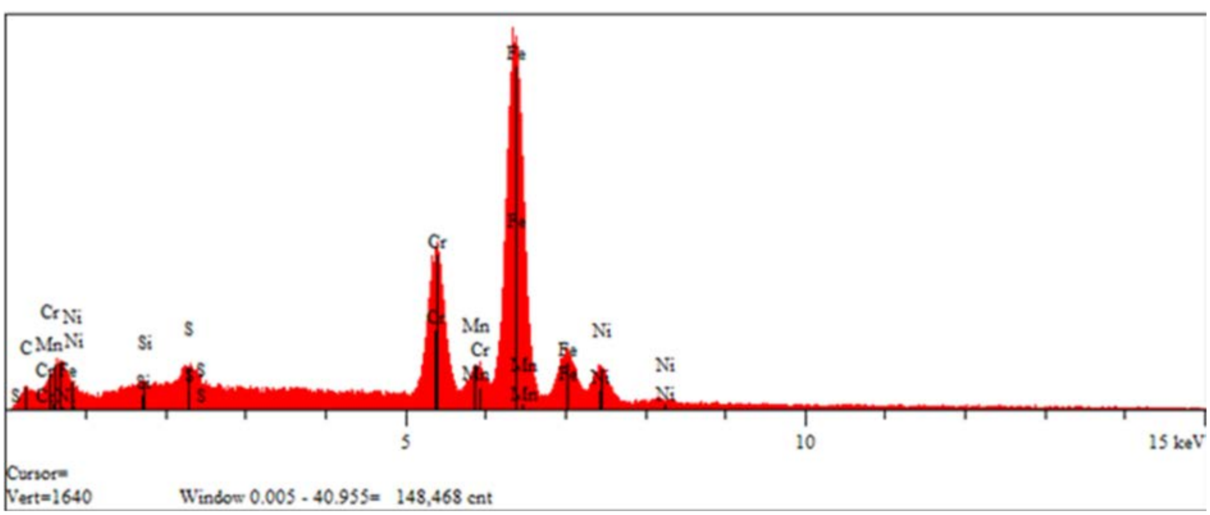


Figure Q - 16 F303 Bottom 25X and EDX Elemental Analysis

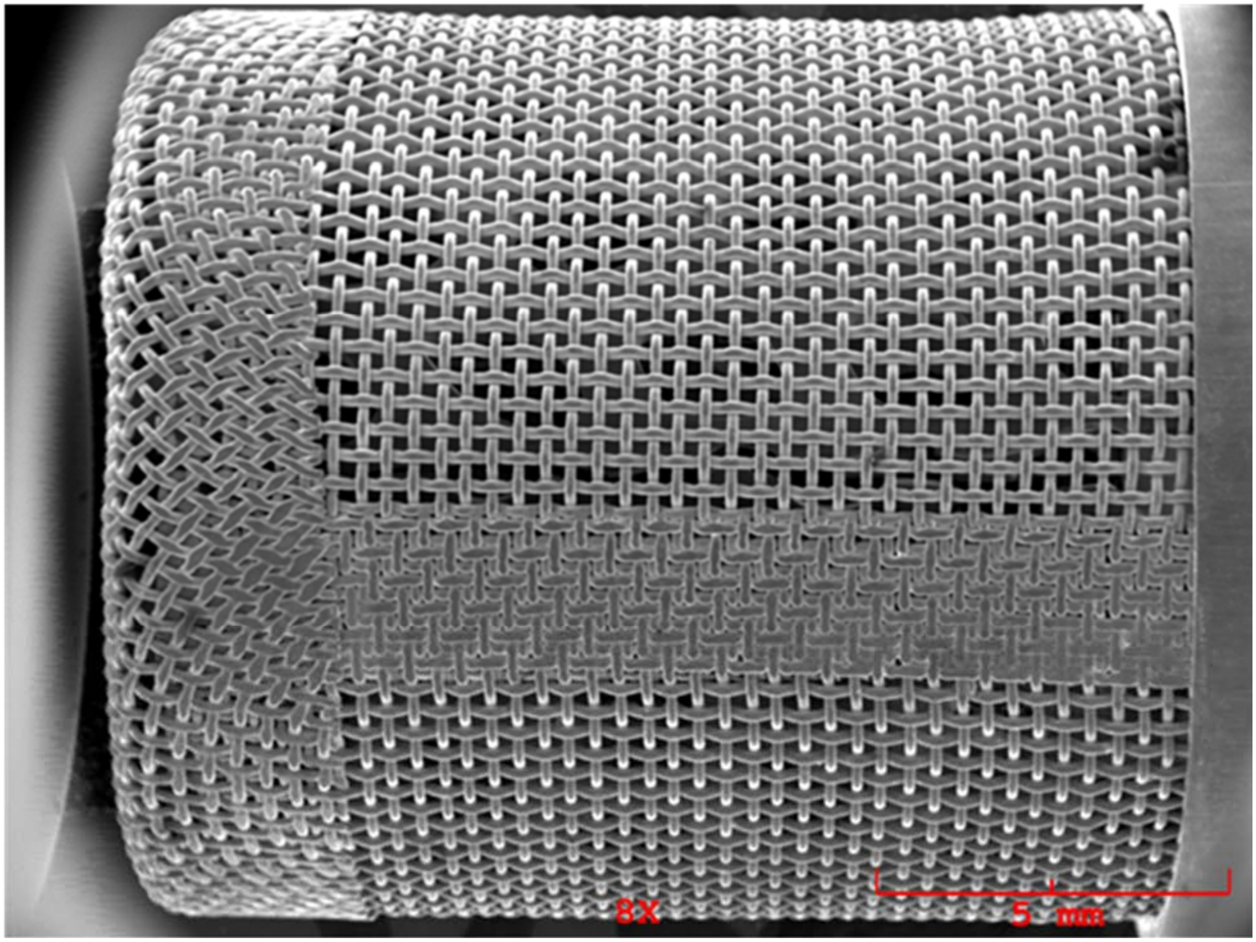
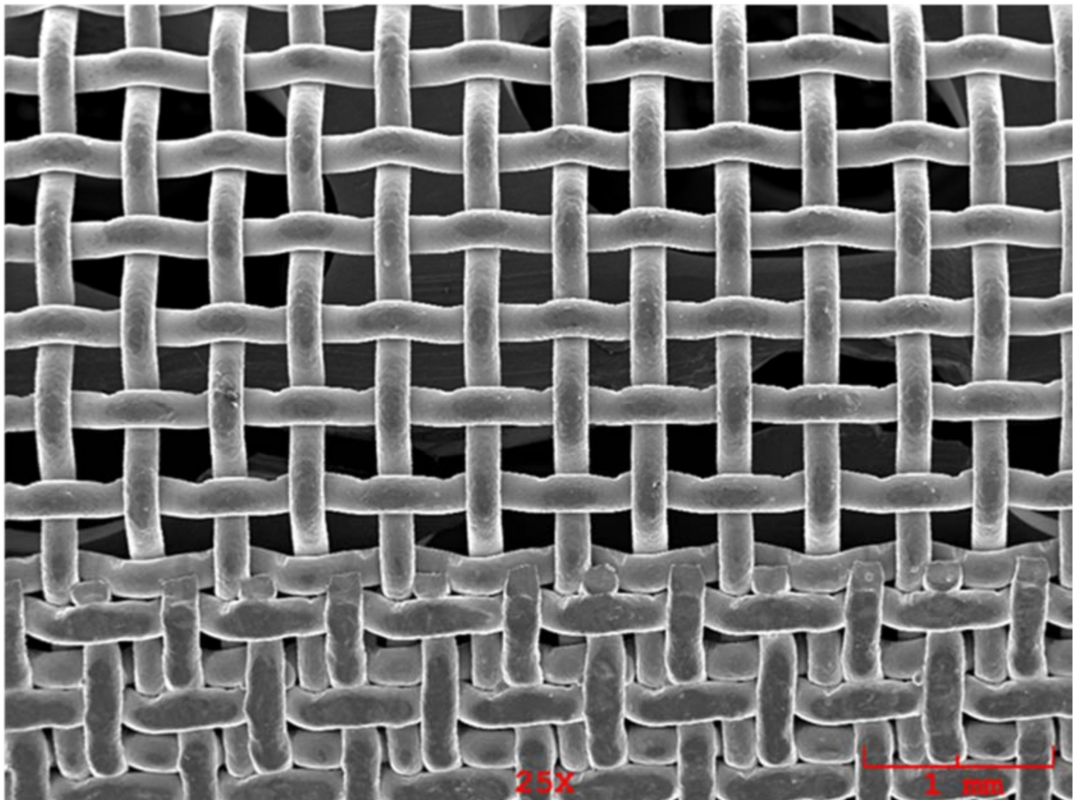


Figure Q - 17 F303 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	4.70	2.555	wt.%	0.441	0.571	
Si	Ka	5.94	0.635	wt.%	0.115	0.157	
S	Ka	16.96	1.428	wt.%	0.111	0.133	
Cr	Ka	135.78	15.694	wt.%	0.298	0.196	
Mn	Ka	5.90	0.941	wt.%	0.201	0.284	
Fe	Ka	361.93	69.605	wt.%	0.763	0.329	
Ni	Ka	31.68	9.142	wt.%	0.421	0.410	
			100.000	wt.%			Total

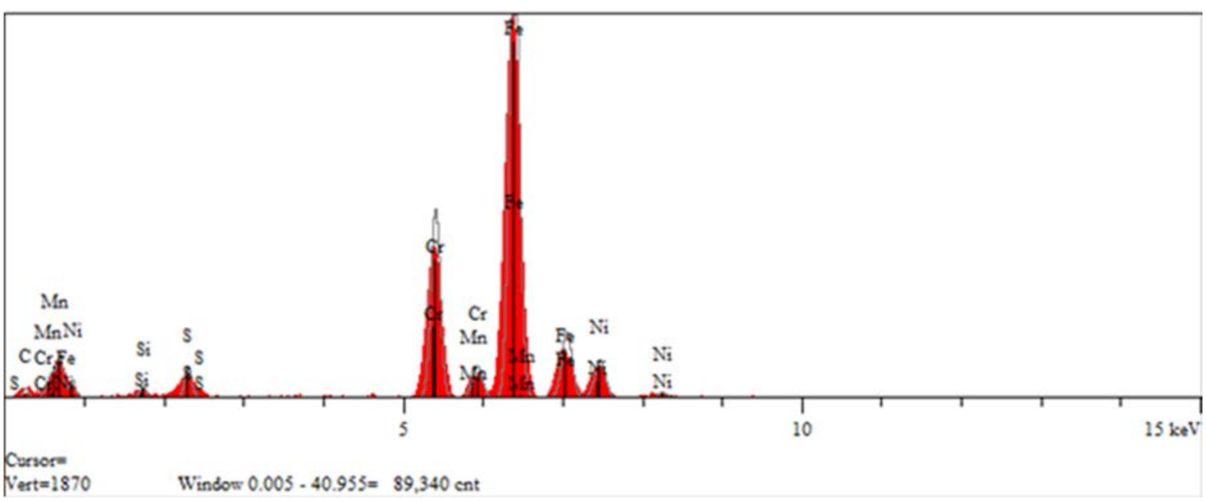


Figure Q - 18 F303 Side 25X and EDX Elemental Analysis

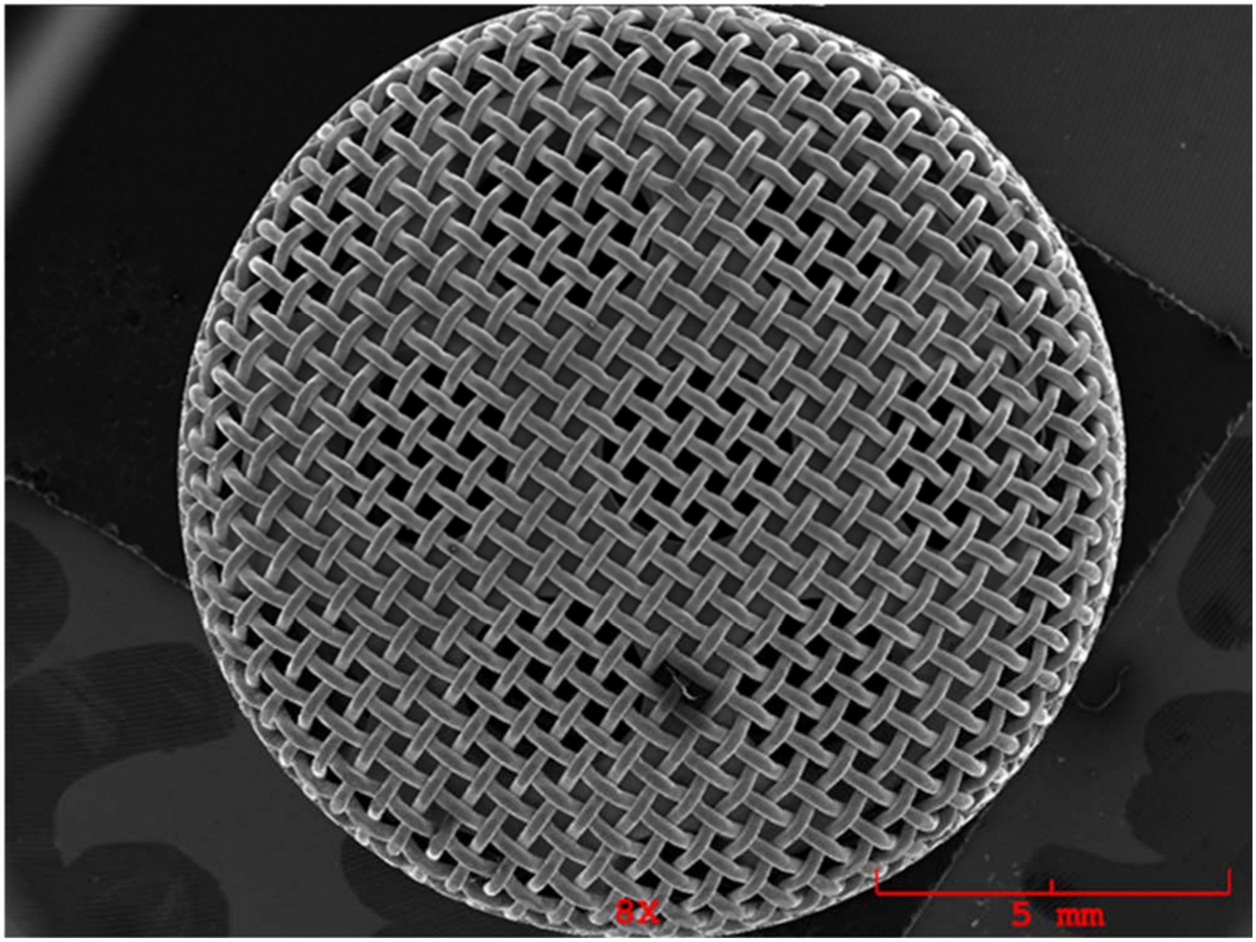
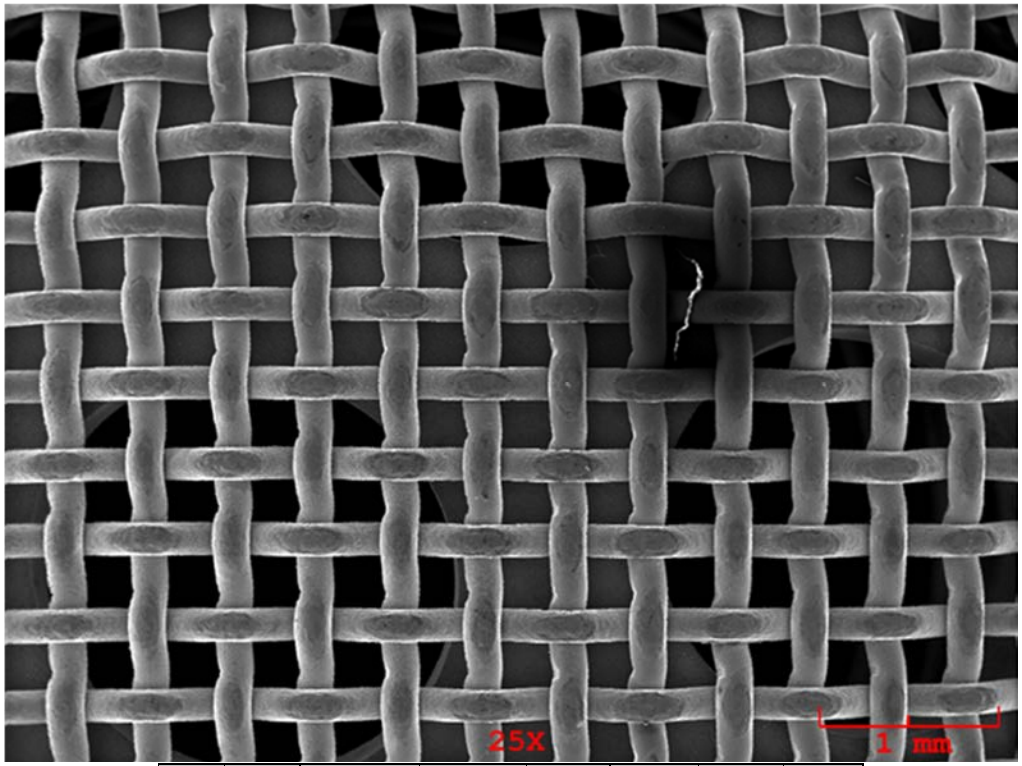


Figure Q - 19 F304 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	4.91	3.179	wt.%	0.535	0.691	
S	Ka	16.05	1.608	wt.%	0.123	0.143	
Cr	Ka	108.61	14.940	wt.%	0.316	0.202	
Mn	Ka	5.19	0.985	wt.%	0.207	0.288	
Fe	Ka	296.76	67.673	wt.%	0.814	0.326	
Ni	Ka	27.93	9.565	wt.%	0.442	0.387	
Cu	Ka	4.85	2.050	wt.%	0.329	0.415	
			100.000	wt.%			Total

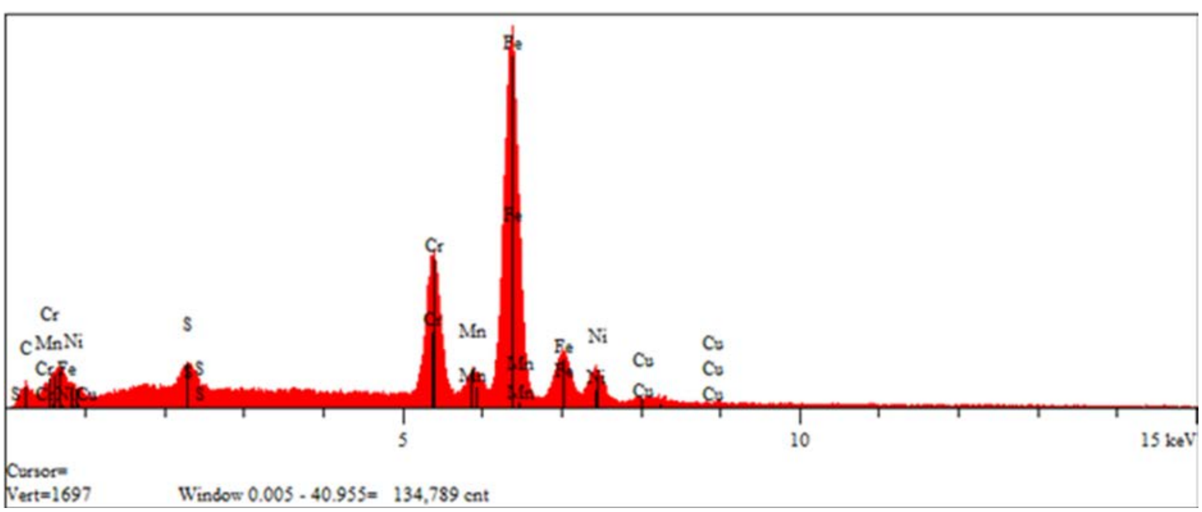


Figure Q - 20 F304 Bottom, 25X and EDX Elemental Analysis

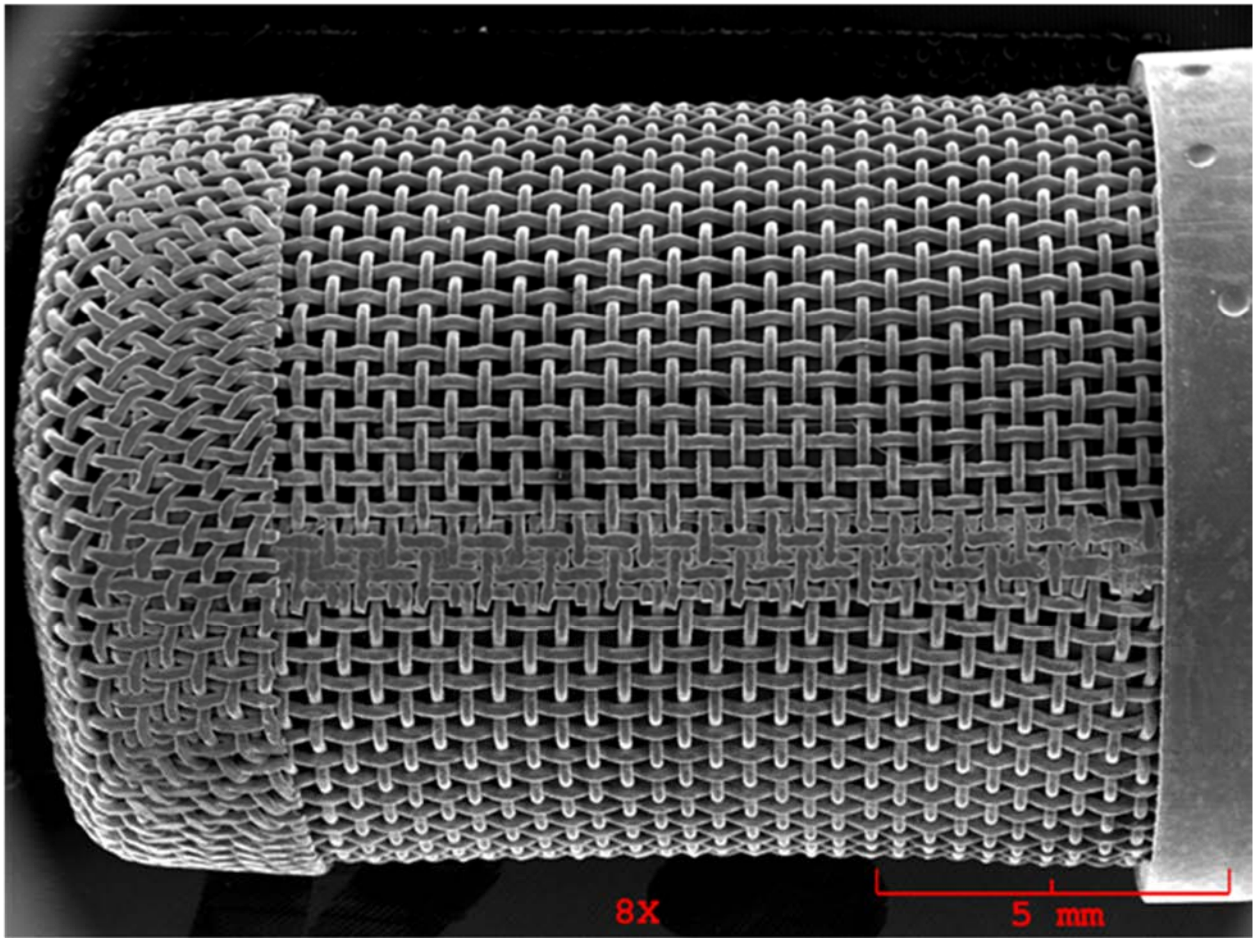
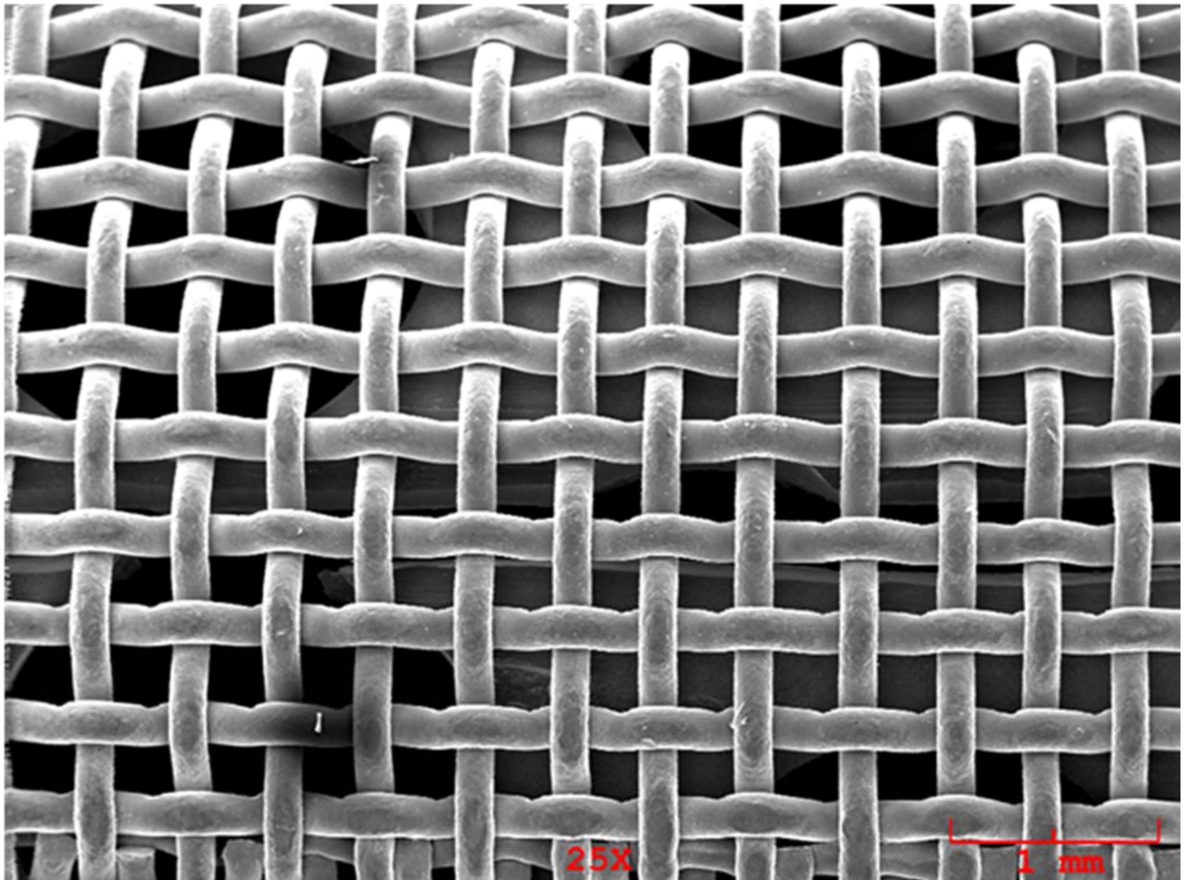


Figure Q - 21 F304 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	5.79	3.450	wt.%	0.482	0.594	
S	Ka	17.68	1.640	wt.%	0.124	0.147	
Cr	Ka	125.43	16.013	wt.%	0.315	0.204	
Fe	Ka	324.26	69.027	wt.%	0.800	0.351	
Ni	Ka	30.93	9.870	wt.%	0.445	0.411	
			100.000	wt.%			Total

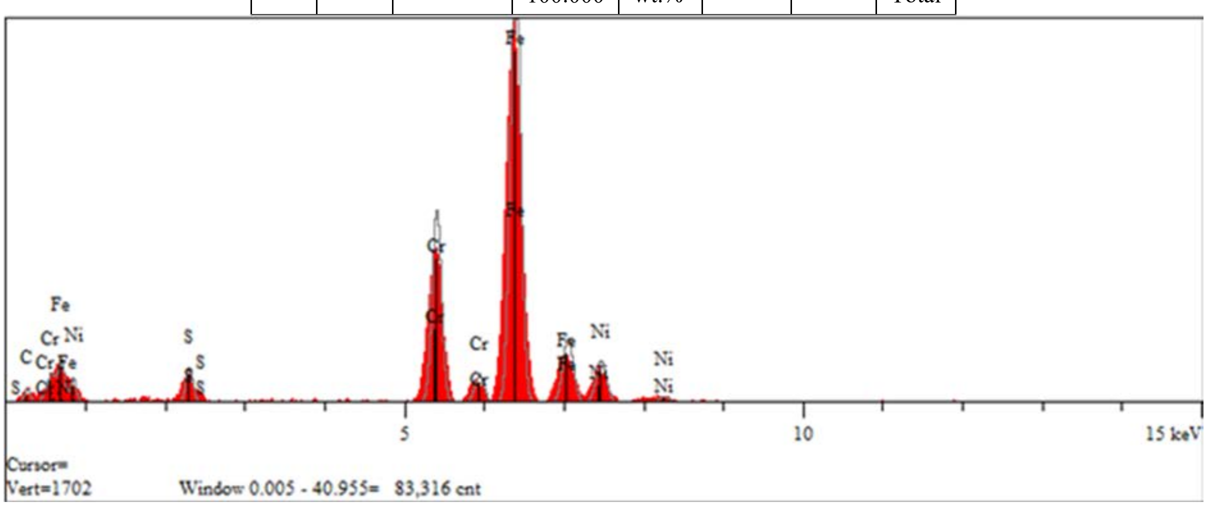


Figure Q - 22 F304 Side, 25X and EDX Elemental Analysis

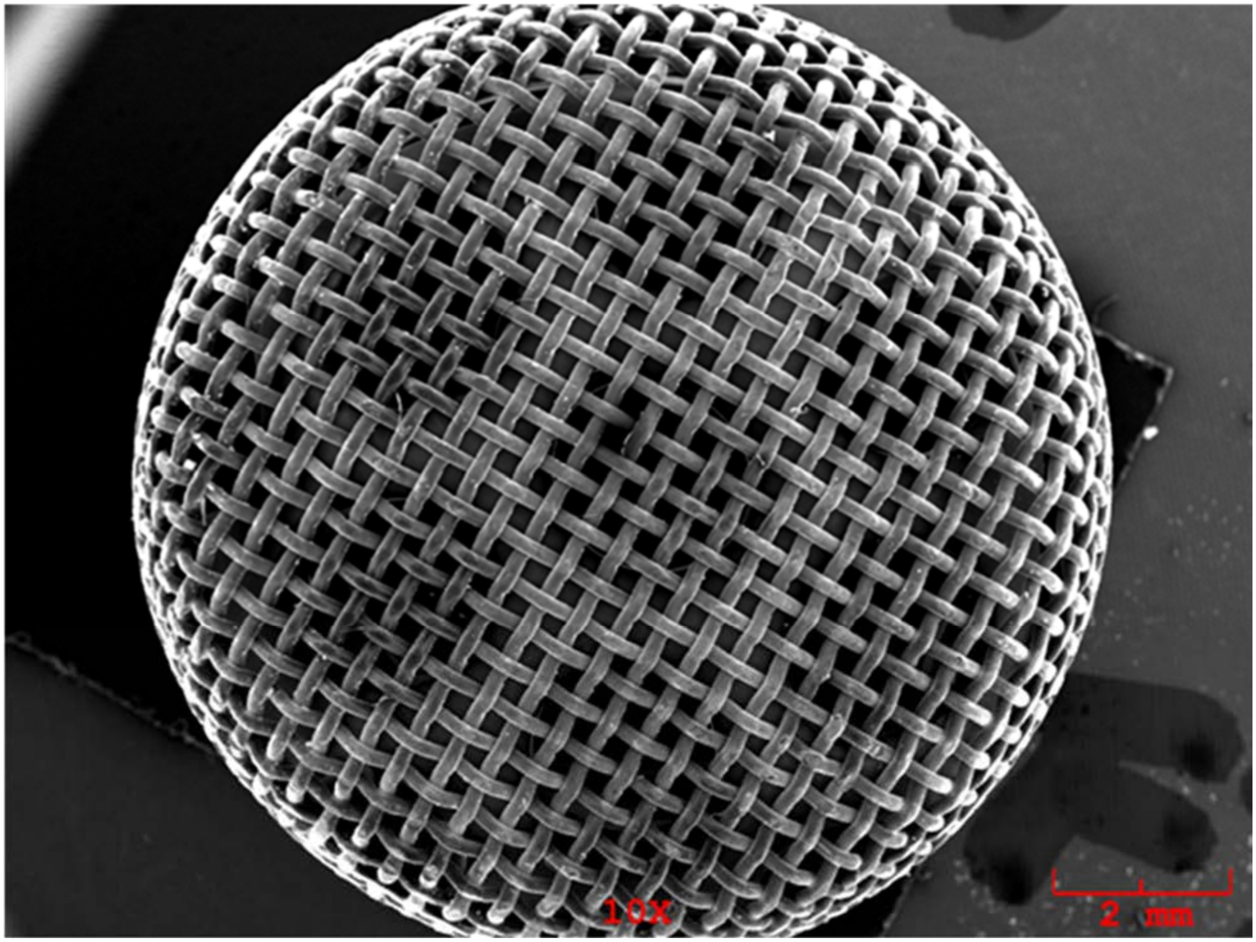
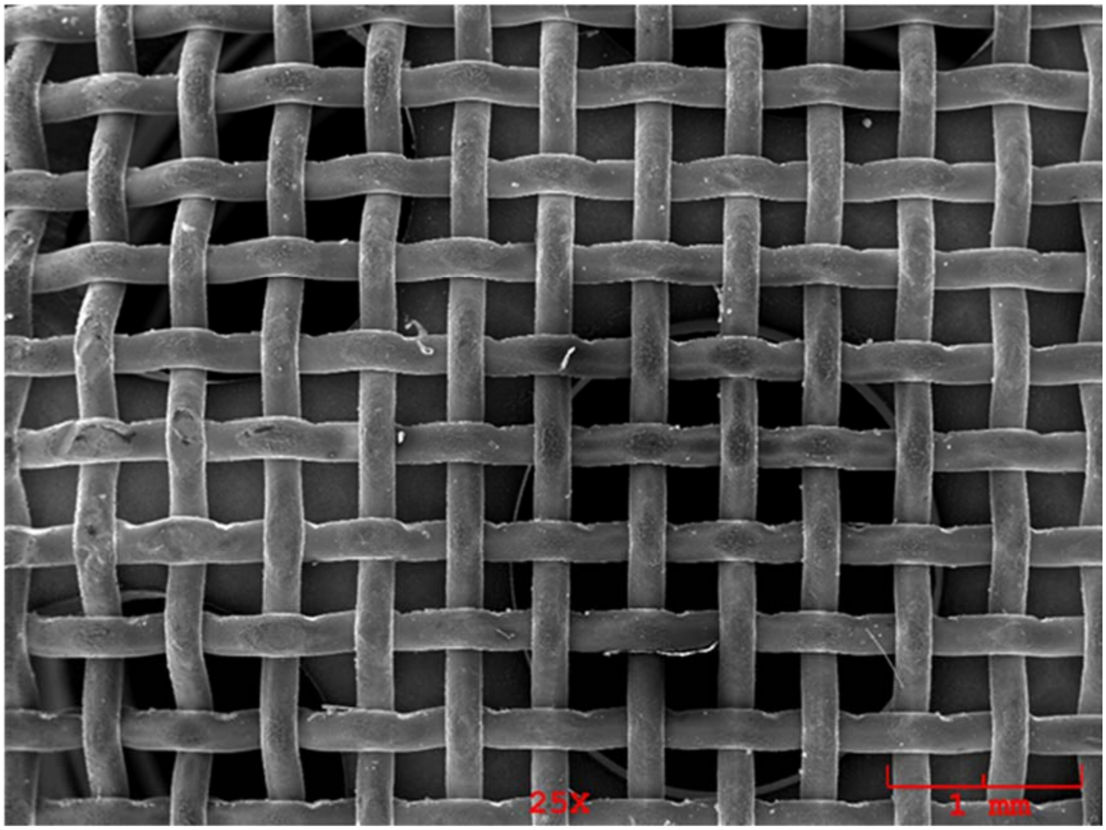


Figure Q - 23 F702 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	24.37	17.779	wt.%	0.966	0.985	
Si	Ka	5.00	0.674	wt.%	0.126	0.170	
S	Ka	36.91	4.061	wt.%	0.168	0.156	
Cr	Ka	78.46	12.834	wt.%	0.322	0.214	
Mn	Ka	5.52	1.227	wt.%	0.223	0.301	
Fe	Ka	212.83	56.576	wt.%	0.809	0.350	
Ni	Ka	17.40	6.851	wt.%	0.441	0.450	
			100.000	wt.%			Total

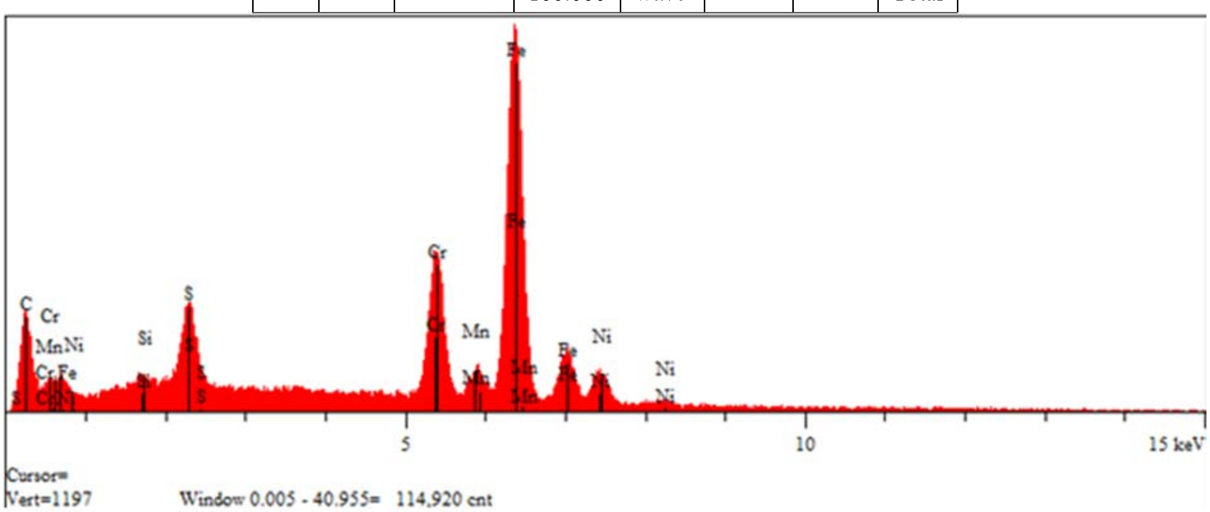


Figure Q - 24 F702 Bottom, 25X and EDX Elemental Analysis

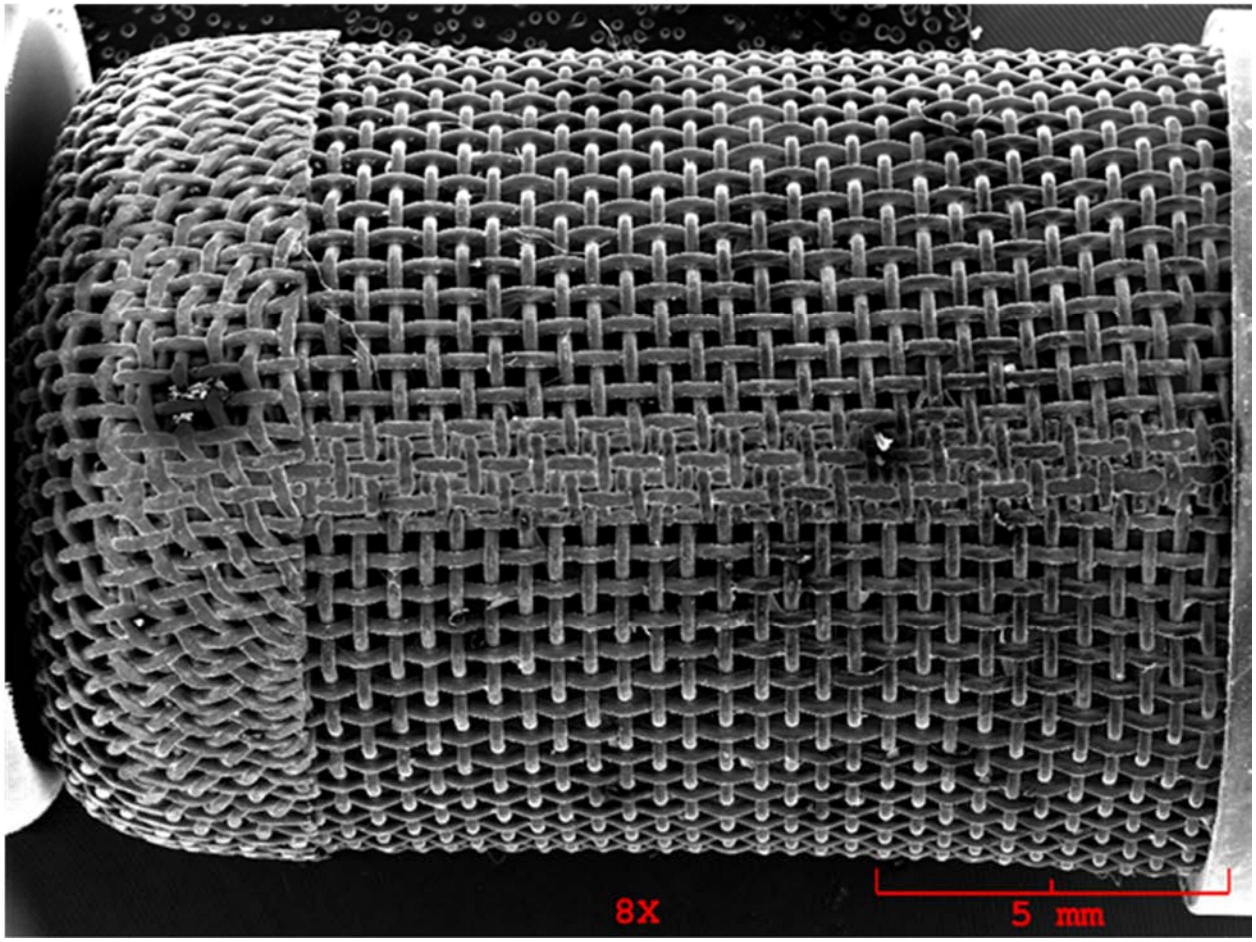
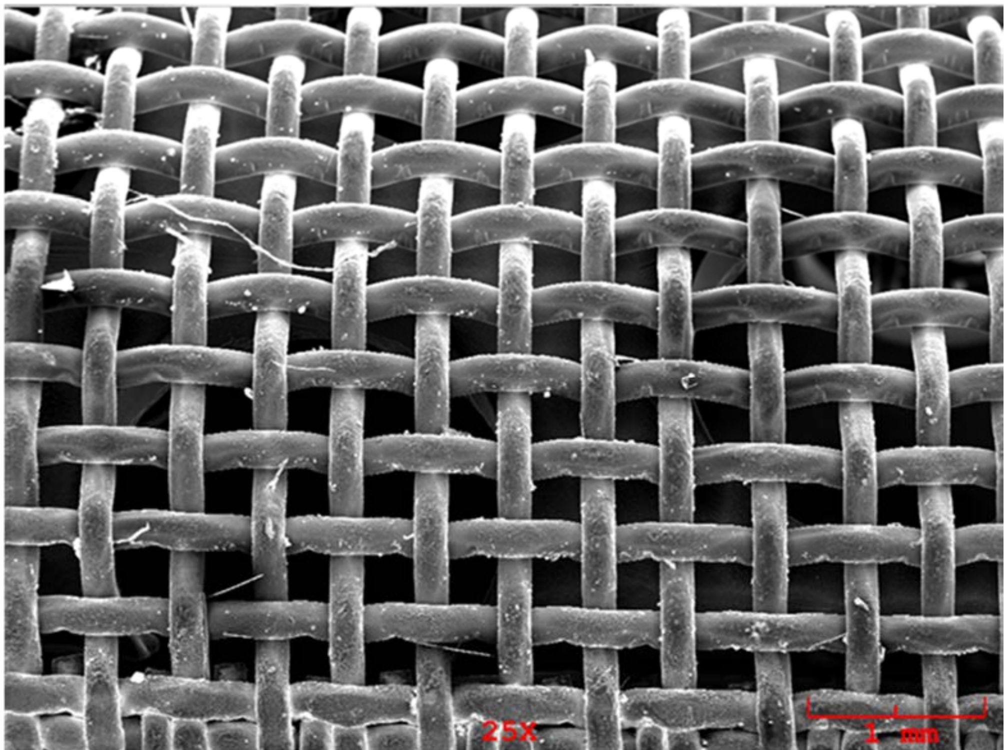


Figure Q - 25 F702 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	25.68	18.878	wt.%	1.031	1.091	
Si	Ka	4.63	0.591	wt.%	0.133	0.185	
S	Ka	53.61	5.619	wt.%	0.187	0.163	
Ca	Ka	2.53	0.283	wt.%	0.109	0.157	
Cr	Ka	79.08	12.566	wt.%	0.317	0.219	
Mn	Ka	3.36	0.720	wt.%	0.219	0.313	
Fe	Ka	212.67	54.398	wt.%	0.784	0.368	
Ni	Ka	18.40	6.945	wt.%	0.444	0.465	
			100.000	wt.%			Total

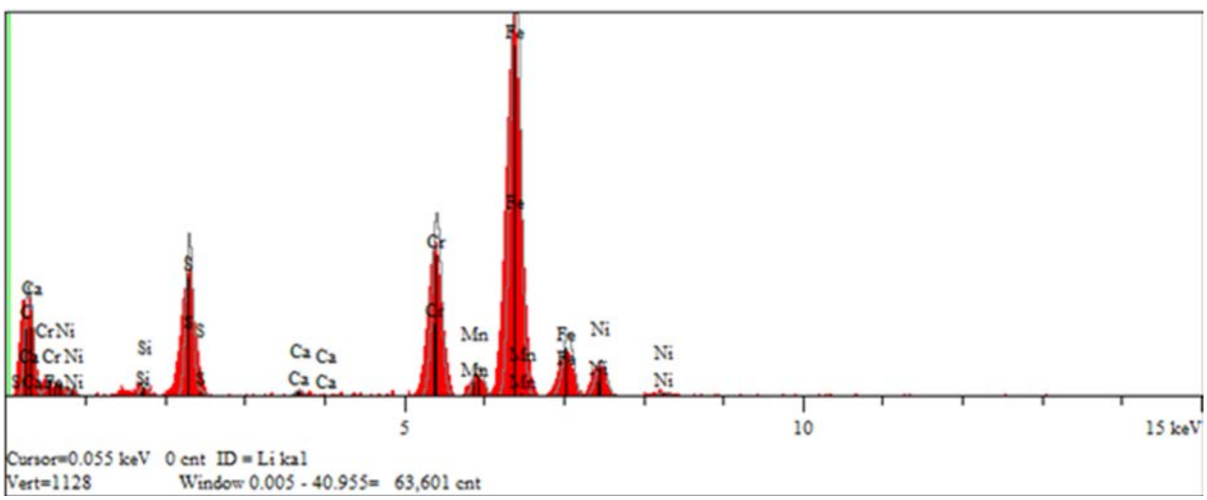


Figure Q -26 F702 Side, 25X and EDX Elemental Analysis

APPENDIX R - RUN 164 DATA PACKAGE

Run Conditions: EDTST Mode, HT Conditions
Fuel ID: POSF-12831, Gulf Coast Jet A
Airframe Heat Exchanger Bulk Fuel Output: 285 °F
HP Pump HX Out/FCOC Bulk Fuel In: 350 °F
Fuel-Cooled Oil Cooler Bulk Fuel Output: 375 °F
Burner Feed Arm Max Wetted Wall Temperature: 510 °F
Run Duration: 72 Hours

DATA SUMMARY

Run 164; Run Type: EDTST; Op Mode: HT; MSNs: N/A; EDTST Run Hours: 72 Fuel ID#: POSF12831; Run Tank: S-15; Run Type: EDTST; Op Mode: HT Fuel Type: Jet-A; Additive(s): None AFHX Out: 285 °F; FCOC In: 325 °F; FCOC Out: 375 °F; BFA MWWT: 510 °F;

Component/Device	Serial No.	Pre-Test %	Post-Test %	Spread (Pre/Post Delta), %	Shift, PPH	Skew, PSID	Flow Range Shift, PPH	Flow Midpoint Shift, PPH	Overall Rating	Hysteresis Area Change (PPH-DP)
FDV	1144	5.4	11.8	6.4	-1.6	0.9	-3.0	-1.5	Moderate	68
Servo2	028	3.1	28.6	25.6	-0.8	-0.2	-0.3	-0.1	Moderate	714

Effective Carbon - µgrams

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	104.4	106.6	72.8	55.9	74.3					
BFA	176.7	274.6	417.5	622.2	671.3	881.0	1030.8	982.1	915.6	776.7
Total FCOC Carbon, µgrams	414.0	µgrams	0.4	mgrams						
Total BFA Carbon, µgrams	6748.4	µgrams	6.7	mgrams						

SCREENS	Total Carbon, µg	Background Carbon, µg	Effective Carbon, µg	MWWT Start	MWWT End	Delta BFA MWWT	TE	BFA AWWT Start	BFA AWWT End	Delta BFA AWWT
TMS	38.3	0.3	38.0	509.47	499.34	-6.30	MAX	491.88	485.94	-5.94
F303	196.6	25.4	171.2	505.18	493.08	-12.09	TE325	SV Inlet	FDV Inlet	BFA Inlet
F304	143.3	12.9	130.4	509.47	498.17	-11.30	TE324	(TE702)	(TE313)	(TE316)
F305	0.0	0.0	0.0	506.06	495.86	-10.20	TE323	367	352	348
F702	1866.9	12.9	1854.0	505.64	499.34	-6.30	TE322			

Effective Carbon Deposition - µgrams/cm^2

Component/Device	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
FCOC Witness Tube	28.6	29.2	20.0	15.3	20.4					
BFA	102.5	159.4	242.3	361.1	389.6	511.4	598.3	570.1	531.4	450.8

TMS Mass Change - grams

Component/Device	Tare, g	Mass, g	Mass Gain, g
TMS	0.08621	0.08634	0.00013
F303	7.08651	7.08707	0.00056
F304	3.05738	3.05787	0.00049
F305	0.00000	0.00000	0.00000
F702	3.05044	3.05389	0.00345

Hysteresis Ratings:

- NONE: indicating that the pre-test and post-test hysteresis curves, for all intents and purposes, are nearly indistinguishable from one another. Minor differences may be seen between the pre-test and post-test curves but these are very small.
- Minor: There are small differences between per- and post-test curves. The spread for these curves is typically within 5% of one another. There may be some small changes in shift and skew for the valve. This degree of hysteresis would not be expected to alter the functional nature of the valve.
- Moderate: There are definite differences between pre-and post-test curves. There may be definite differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically between 5% and 15%. This degree of hysteresis might be expected to alter the functional nature of the valve.
- Severe: There are pronounce differences between pre-and post-test curves. There may be pronounced differences in shift and skew as well. It is clear that there is hysteresis in this valve. Pre- and post-test spread will be typically in excess 15%. This degree of hysteresis would be considered out-of-spec for the valve.
- Non-Functional: There are major differences between pre-and post-test curves. There may be major differences in shift and skew as well. The hysteresis curve will exhibit flat segments (either vertically or horizontally). Shift and skew have majorly changed the performance envelope of the valve. This degree of hysteresis would cause the valve to be non-functional or unresponsive over small or large portions of the performance range of the valve.

Figure R - 1 Run 164 Data Summary

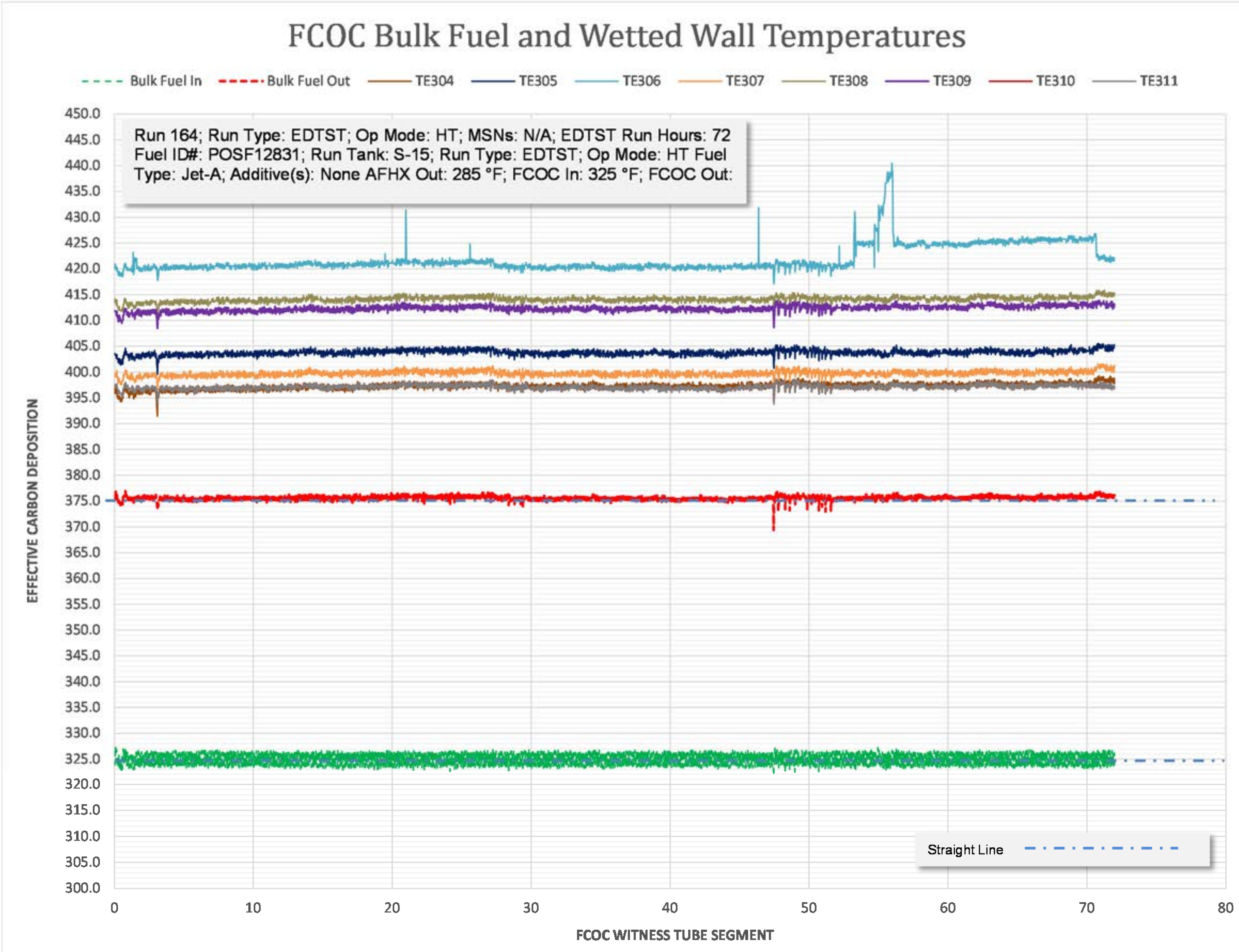


Figure R - 2 FCOC Bulk Fuel and Wetted Wall Temperatures

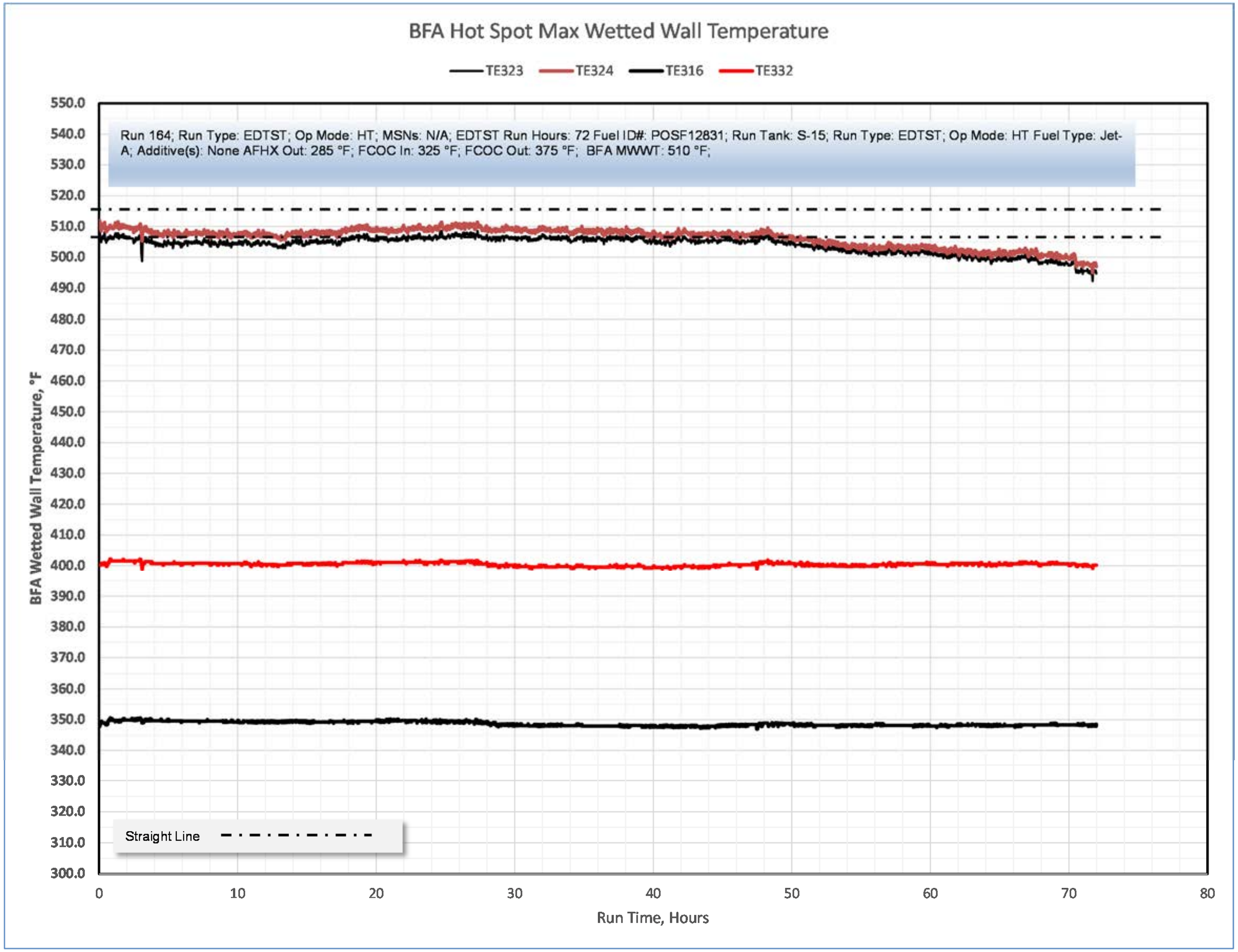


Figure R - 3 BFA Hot Spot Max Wetted Wall And Bulk Fuel Temperatures

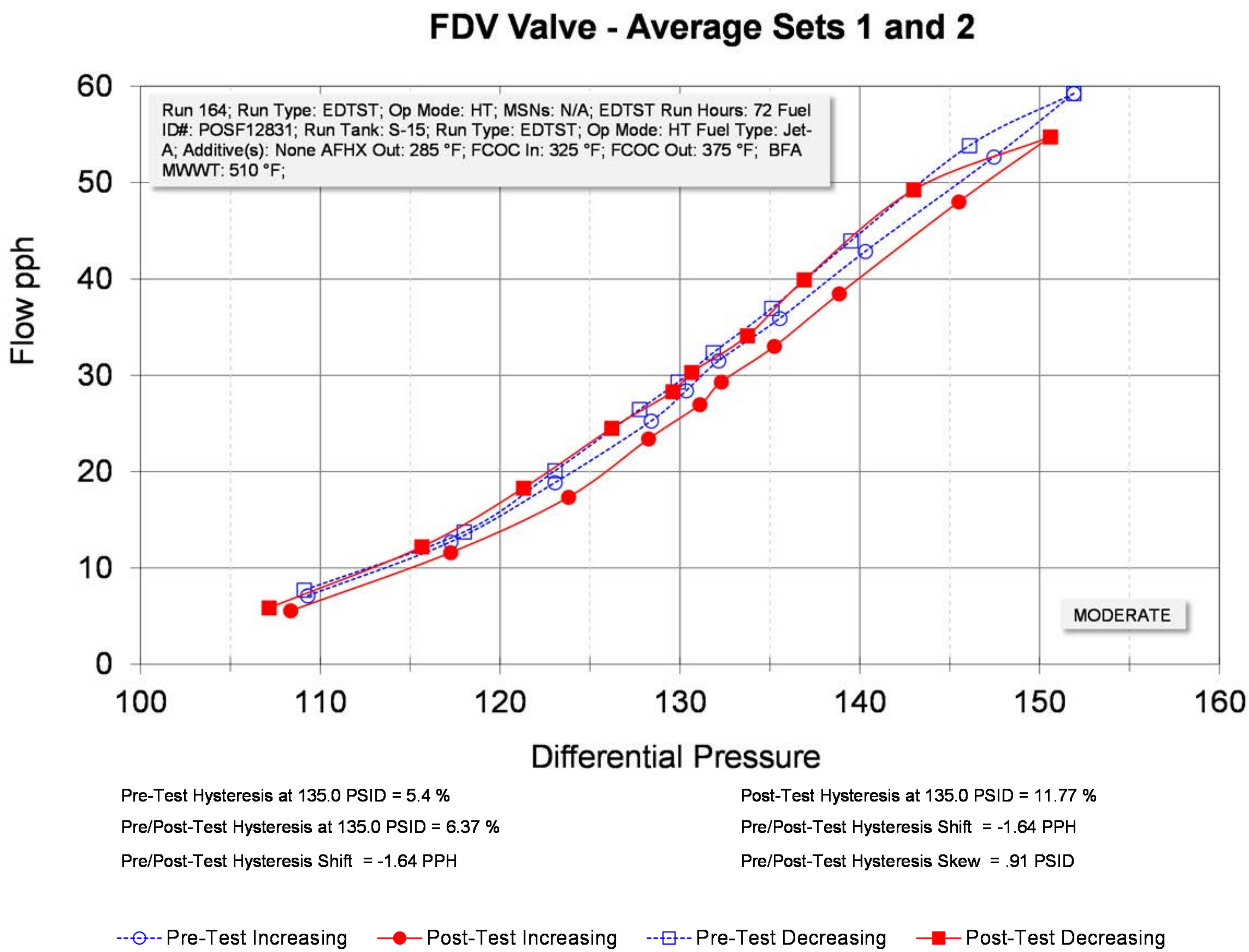


Figure R - 4 FDV Hysteresis

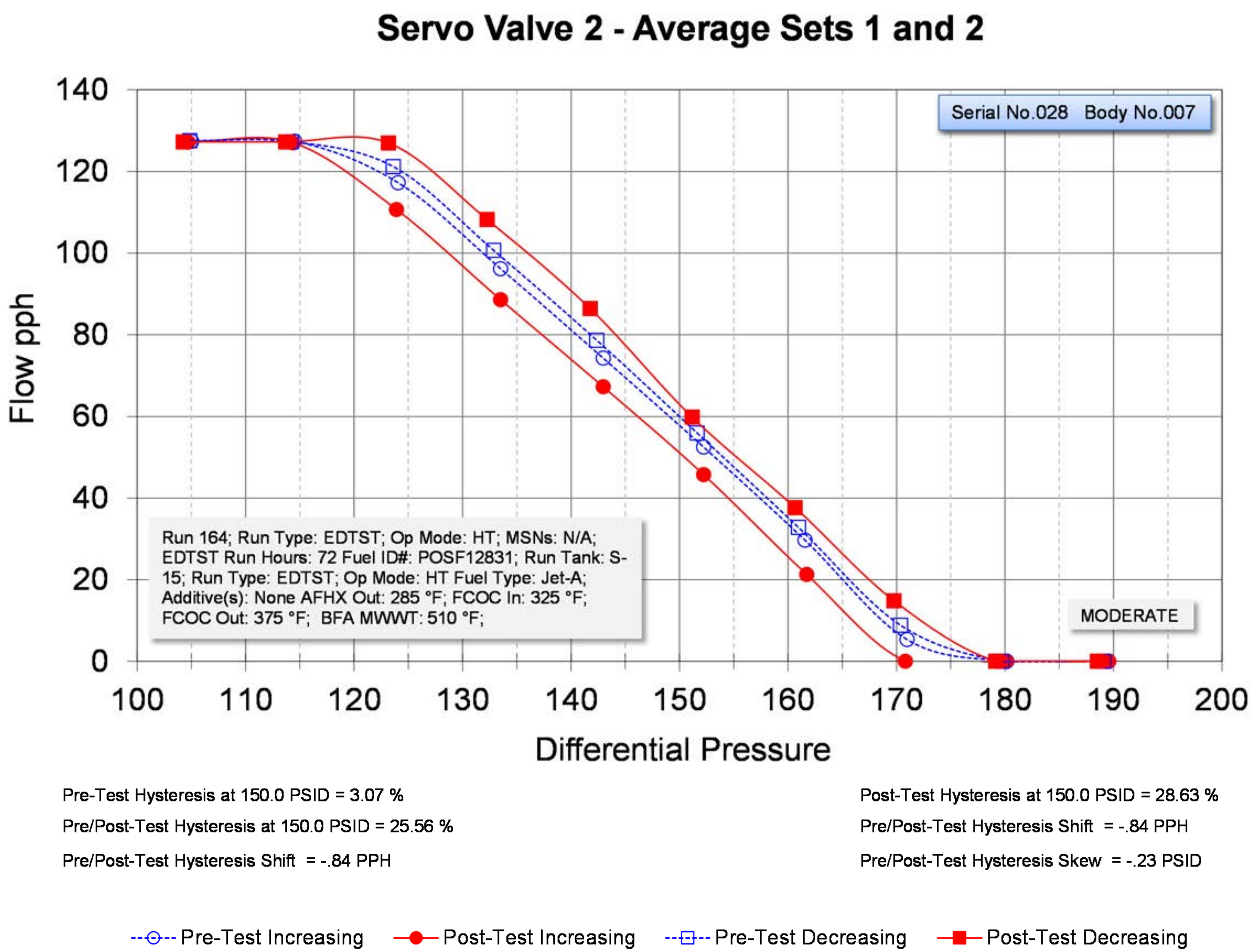


Figure R - 5 Servo Valve Hysteresis

Figure R - 6 FDV Components - Comparison to Clean

Servo Valve and Nozzle Screen Simulator Components – Comparison To Clean - Run 164

Run 164

Clean

Run 164 POSF-12831 HT 22

Figure R - 7 Servo Valve and Nozzle Screen Components - Comparison to Clean

TMS Components – Run 164

Run 164 POSF-12831 HT 20

Figure R - 8 TMS Screen Top and Bottom - Comparison to Clean

GCxGC Results

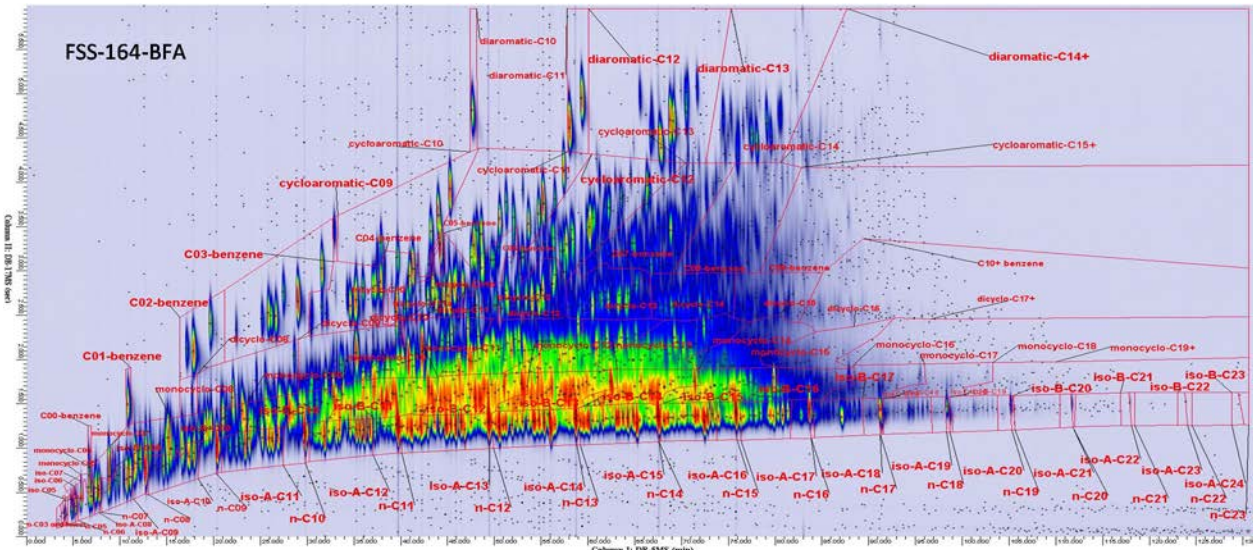


Figure R - 9 GCxGC Summary POSF-12831 BFA Outlet

Table R - 1 GCxGC Tabulated Data POSF-12831 Jet A Neat and Run 151 BFA Outlet

GCxGC Summary	POSF-12831-Jet A Neat		FSS164-BFA	
Hydrogen content (weight %)	13.9		13.9	
Average Molecular Wt (g/mole)	168		168	
	Weight %	Volume %	Weight %	Volume %
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	0.01	0.01
toluene (C07)	0.10	0.10	0.10	0.09
C2-benzene (C08)	0.42	0.39	0.41	0.38
C3-benzene (C09)	0.88	0.82	0.86	0.80
C4-benzene (C10)	1.47	1.37	1.51	1.41
C5-benzene (C11)	1.78	1.66	1.70	1.58
C6-benzene (C12)	1.69	1.58	1.65	1.54
C7-benzene (C13)	1.21	1.13	1.19	1.11
C8-benzene (C14)	0.99	0.92	0.98	0.91
C9-benzene (C15)	0.55	0.51	0.56	0.52
C10+-benzene (C16+)	0.24	0.23	0.23	0.21
Total Alkylbenzenes	**9.33**	8.69	**9.18**	8.56
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.11	0.08
diaromatic-C11	0.51	0.40	0.50	0.39
diaromatic-C12	0.96	0.77	0.92	0.74
diaromatic-C13	0.58	0.47	0.57	0.46
diaromatic-C14+	0.18	0.15	0.16	0.13
Total Alkylnaphthalenes	**2.33**	1.87	**2.26**	1.82
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.03	0.02	0.03	0.02
cycloaromatic-C10	0.53	0.44	0.53	0.44
cycloaromatic-C11	1.54	1.32	1.54	1.32
cycloaromatic-C12	1.67	1.45	1.61	1.40
cycloaromatic-C13	1.54	1.35	1.64	1.44
cycloaromatic-C14	0.94	0.83	0.94	0.82
cycloaromatics-C15+	0.30	0.26	0.27	0.23
Total Cycloaromatics	**6.56**	5.67	**6.55**	5.67
Total Aromatics	**18.22**	**16.24**	**18.00**	**16.05**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.24	0.29	0.14	0.16
C08-isoparaffins	0.43	0.49	0.41	0.47
C09-isoparaffins	0.58	0.65	0.61	0.69
C10-isoparaffins	1.46	1.61	1.47	1.62
C11-isoparaffins	2.76	2.99	2.81	3.04
C12-isoparaffins	4.56	4.94	4.57	4.95
C13-isoparaffins	4.75	5.04	4.62	4.90
C14-isoparaffins	4.49	4.72	4.48	4.71
C15-isoparaffins	3.64	3.81	3.77	3.94
C16-isoparaffins	1.50	1.55	1.50	1.56
C17-isoparaffins	0.46	0.47	0.45	0.46
C18-isoparaffins	0.15	0.16	0.17	0.17
C19-isoparaffins	0.08	0.08	0.07	0.07
C20-isoparaffins	0.05	0.05	0.04	0.05
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01
Total iso-Paraffins	**25.16**	26.85	**25.11**	26.79

n-Paraffins				
n-C07 & lower	0.19	0.22	0.18	0.22
n-C08	0.38	0.43	0.35	0.40
n-C09	0.56	0.62	0.55	0.61
n-C10	1.00	1.10	1.01	1.11
n-C11	2.89	3.13	2.94	3.19
n-C12	3.11	3.32	3.10	3.32
n-C13	2.77	2.94	2.78	2.95
n-C14	2.38	2.50	2.41	2.53
n-C15	1.40	1.46	1.43	1.49
n-C16	0.34	0.36	0.36	0.37
n-C17	0.12	0.13	0.11	0.12
n-C18	0.04	0.04	0.03	0.04
n-C19	0.02	0.02	0.02	0.02
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**15.22**	16.30	**15.30**	16.39
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.49	0.51	0.54	0.57
C08-monocyclocycloparaffins	0.71	0.72	0.68	0.70
C09-monocyclocycloparaffins	1.49	1.51	1.41	1.43
C10-monocyclocycloparaffins	2.36	2.32	2.18	2.14
C11-monocyclocycloparaffins	5.59	5.63	5.37	5.41
C12-monocyclocycloparaffins	5.49	5.49	6.02	6.02
C13-monocyclocycloparaffins	5.81	5.75	5.51	5.45
C14-monocyclocycloparaffins	4.05	4.02	4.04	4.01
C15-monocyclocycloparaffins	2.58	2.55	2.54	2.52
C16-monocyclocycloparaffins	0.93	0.92	0.74	0.73
C17-monocyclocycloparaffins	0.23	0.22	0.24	0.23
C18-monocyclocycloparaffins	0.06	0.06	0.06	0.06
C19+-monocyclocycloparaffins	0.04	0.03	0.03	0.03
Total Monocycloparaffins	**29.82**	29.73	**29.36**	29.28
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.27	0.25	0.35	0.32
C10-dicycloparaffins	0.71	0.64	0.86	0.77
C11-dicycloparaffins	2.43	2.28	2.23	2.10
C12-dicycloparaffins	2.60	2.46	2.90	2.74
C13-dicycloparaffins	2.89	2.73	2.99	2.82
C14-dicycloparaffins	1.89	1.78	1.89	1.78
C15-dicycloparaffins	0.63	0.59	0.71	0.67
C16-dicycloparaffins	0.04	0.03	0.22	0.20
C17+-dicycloparaffins	0.03	0.03	0.03	0.03
Total Dicycloparaffins	**11.50**	10.81	**12.19**	11.46
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.07	0.06	0.04	0.04
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.08**	0.06	**0.04**	0.04
Total Cycloparaffins	**41.40**	40.61	**41.59**	40.78
Average Molecular Formula - C	12.1		12.1	
Average Molecular Formula - H	23.2		23.2	

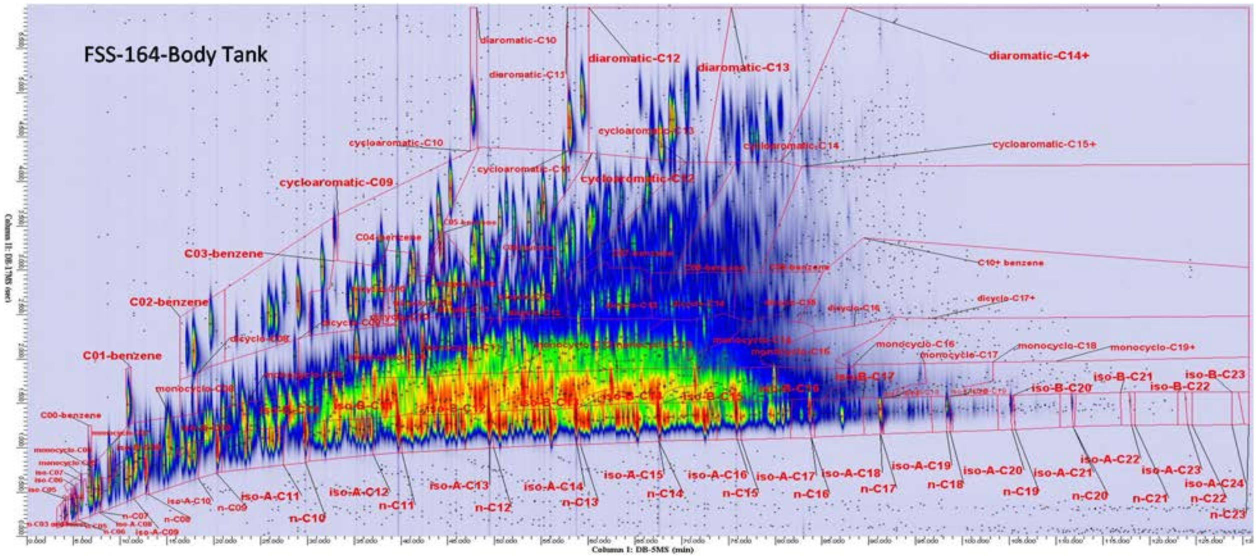


Figure R - 10 GCxGC Summary Fuel From Body Tank

Table R - 2 GCxGC Tabulated Data - Fuel From Body Tank at the End Of Run

GCxGC Summary				
Hydrogen content (weight %)	13.9		13.9	
Average Molecular Wt (g/mole)	168		168	
	POSF-12831-Jet A Neat		**FSS164-Body Tar**	
	Weight %	Volume %	Weight %	Volume %
Aromatics				
Alkylbenzenes				
benzene (C06)	<0.01	<0.01	0.02	0.02
toluene (C07)	0.10	0.10	0.10	0.09
C2-benzene (C08)	0.42	0.39	0.41	0.38
C3-benzene (C09)	0.88	0.82	0.86	0.80
C4-benzene (C10)	1.47	1.37	1.51	1.41
C5-benzene (C11)	1.78	1.66	1.70	1.58
C6-benzene (C12)	1.69	1.58	1.64	1.53
C7-benzene (C13)	1.21	1.13	1.23	1.15
C8-benzene (C14)	0.99	0.92	0.99	0.93
C9-benzene (C15)	0.55	0.51	0.56	0.53
C10+-benzene (C16+)	0.24	0.23	0.23	0.21
Total Alkylbenzenes	**9.33**	8.69	**9.25**	8.62
Diaromatics (Naphthalenes, Biphenyls, etc.)				
diaromatic-C10	0.11	0.08	0.11	0.08
diaromatic-C11	0.51	0.40	0.50	0.39
diaromatic-C12	0.96	0.77	0.94	0.76
diaromatic-C13	0.58	0.47	0.58	0.47
diaromatic-C14+	0.18	0.15	0.16	0.13
Total Alkylnaphthalenes	**2.33**	1.87	**2.28**	1.83
Cycloaromatics (Indans, Tetralins,etc.)				
cycloaromatic-C09	0.03	0.02	0.03	0.02
cycloaromatic-C10	0.53	0.44	0.53	0.44
cycloaromatic-C11	1.54	1.32	1.55	1.33
cycloaromatic-C12	1.67	1.45	1.58	1.38
cycloaromatic-C13	1.54	1.35	1.65	1.44
cycloaromatic-C14	0.94	0.83	0.92	0.80
cycloaromatics-C15+	0.30	0.26	0.29	0.25
Total Cycloaromatics	**6.56**	5.67	**6.55**	5.67
Total Aromatics	**18.22**	**16.24**	**18.08**	**16.12**
Paraffins				
iso-Paraffins				
C07 & lower -isoparaffins	0.24	0.29	0.13	0.16
C08-isoparaffins	0.43	0.49	0.43	0.49
C09-isoparaffins	0.58	0.65	0.60	0.67
C10-isoparaffins	1.46	1.61	1.49	1.65
C11-isoparaffins	2.76	2.99	2.78	3.01
C12-isoparaffins	4.56	4.94	4.47	4.85
C13-isoparaffins	4.75	5.04	4.82	5.11
C14-isoparaffins	4.49	4.72	4.29	4.51
C15-isoparaffins	3.64	3.81	3.77	3.93
C16-isoparaffins	1.50	1.55	1.48	1.53
C17-isoparaffins	0.46	0.47	0.43	0.45
C18-isoparaffins	0.15	0.16	0.15	0.16
C19-isoparaffins	0.08	0.08	0.06	0.06
C20-isoparaffins	0.05	0.05	0.04	0.04
C21-isoparaffins	<0.01	<0.01	<0.01	<0.01
C22-isoparaffins	<0.01	<0.01	<0.01	<0.01
C23-isoparaffins	<0.01	<0.01	<0.01	<0.01
C24-isoparaffins	<0.01	<0.01	<0.01	<0.01
Total iso-Paraffins	**25.16**	26.85	**24.95**	26.63

n-Paraffins				
n-C07 & lower	0.19	0.22	0.18	0.22
n-C08	0.38	0.43	0.37	0.42
n-C09	0.56	0.62	0.55	0.61
n-C10	1.00	1.10	1.02	1.12
n-C11	2.89	3.13	2.88	3.13
n-C12	3.11	3.32	3.17	3.39
n-C13	2.77	2.94	2.80	2.97
n-C14	2.38	2.50	2.46	2.58
n-C15	1.40	1.46	1.43	1.49
n-C16	0.34	0.36	0.36	0.37
n-C17	0.12	0.13	0.13	0.14
n-C18	0.04	0.04	0.04	0.04
n-C19	0.02	0.02	0.02	0.02
n-C20	<0.01	<0.01	<0.01	<0.01
n-C21	<0.01	<0.01	<0.01	<0.01
n-C22	<0.01	<0.01	<0.01	<0.01
n-C23	<0.01	<0.01	<0.01	<0.01
Total n-Paraffins	**15.22**	16.30	**15.42**	16.51
Cycloparaffins				
Monocycloparaffins				
C07 & lower monocycloparaffins	0.49	0.51	0.54	0.56
C08-monocyclocycloparaffins	0.71	0.72	0.68	0.69
C09-monocyclocycloparaffins	1.49	1.51	1.42	1.43
C10-monocyclocycloparaffins	2.36	2.32	2.18	2.14
C11-monocyclocycloparaffins	5.59	5.63	5.32	5.36
C12-monocyclocycloparaffins	5.49	5.49	6.12	6.13
C13-monocyclocycloparaffins	5.81	5.75	5.35	5.29
C14-monocyclocycloparaffins	4.05	4.02	3.97	3.94
C15-monocyclocycloparaffins	2.58	2.55	2.66	2.63
C16-monocyclocycloparaffins	0.93	0.92	0.78	0.77
C17-monocyclocycloparaffins	0.23	0.22	0.27	0.27
C18-monocyclocycloparaffins	0.06	0.06	0.06	0.06
C19+-monocyclocycloparaffins	0.04	0.03	0.03	0.03
Total Monocycloparaffins	**29.82**	29.73	**29.38**	29.30
Dicycloparaffins				
C08-dicycloparaffins	0.02	0.02	0.02	0.02
C09-dicycloparaffins	0.27	0.25	0.31	0.29
C10-dicycloparaffins	0.71	0.64	0.91	0.82
C11-dicycloparaffins	2.43	2.28	2.41	2.27
C12-dicycloparaffins	2.60	2.46	2.80	2.65
C13-dicycloparaffins	2.89	2.73	2.88	2.72
C14-dicycloparaffins	1.89	1.78	1.90	1.79
C15-dicycloparaffins	0.63	0.59	0.65	0.62
C16-dicycloparaffins	0.04	0.03	0.22	0.21
C17+-dicycloparaffins	0.03	0.03	0.02	0.02
Total Dicycloparaffins	**11.50**	10.81	**12.13**	11.40
Tricycloparaffins				
C10-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
C11-tricycloparaffins	0.07	0.06	0.04	0.04
C12-tricycloparaffins	<0.01	<0.01	<0.01	<0.01
Total Tricycloparaffins	**0.08**	0.06	**0.04**	0.04
Total Cycloparaffins	**41.40**	40.61	**41.55**	40.74
Average Molecular Formula - C	12.1		12.1	
Average Molecular Formula - H	23.2		23.2	

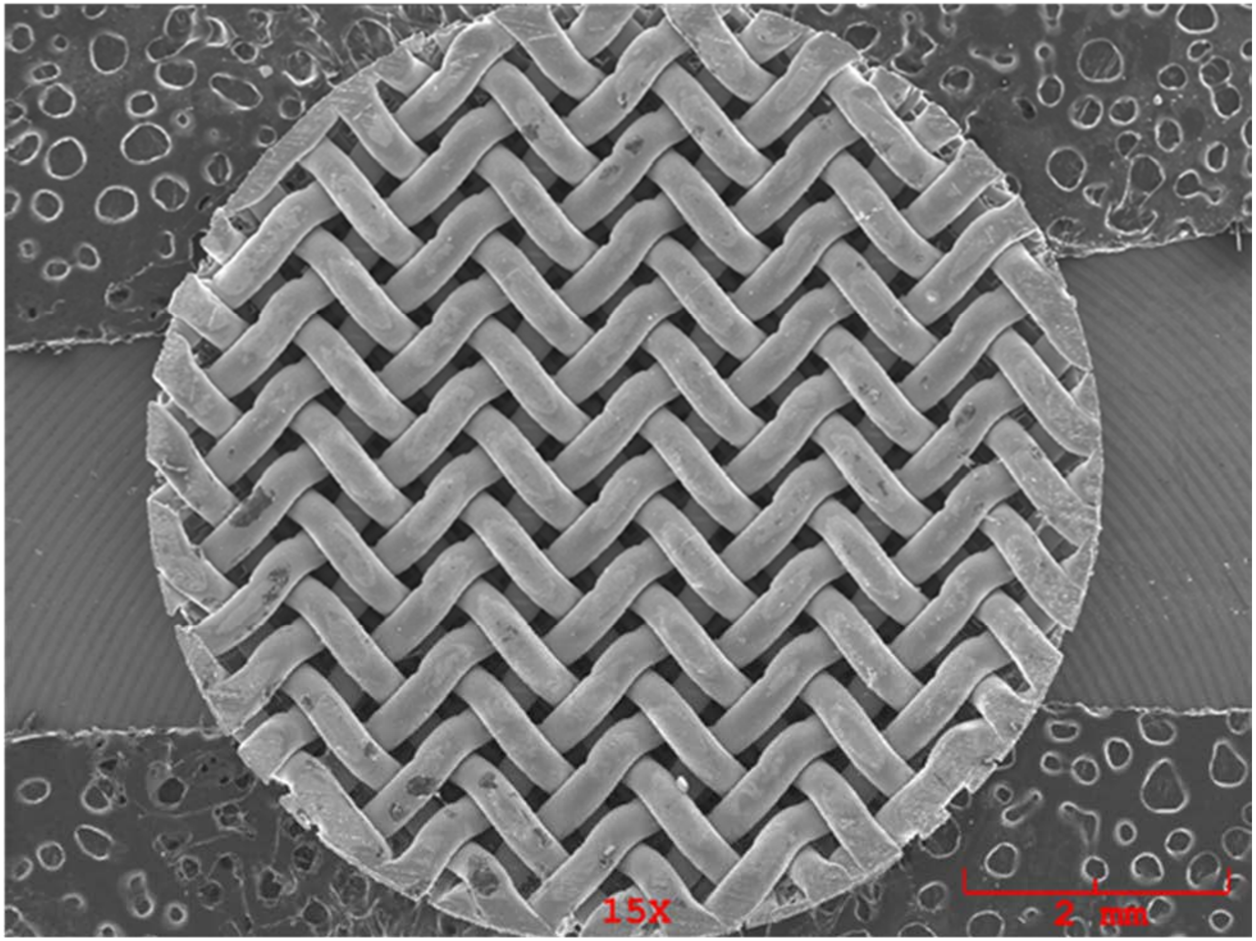
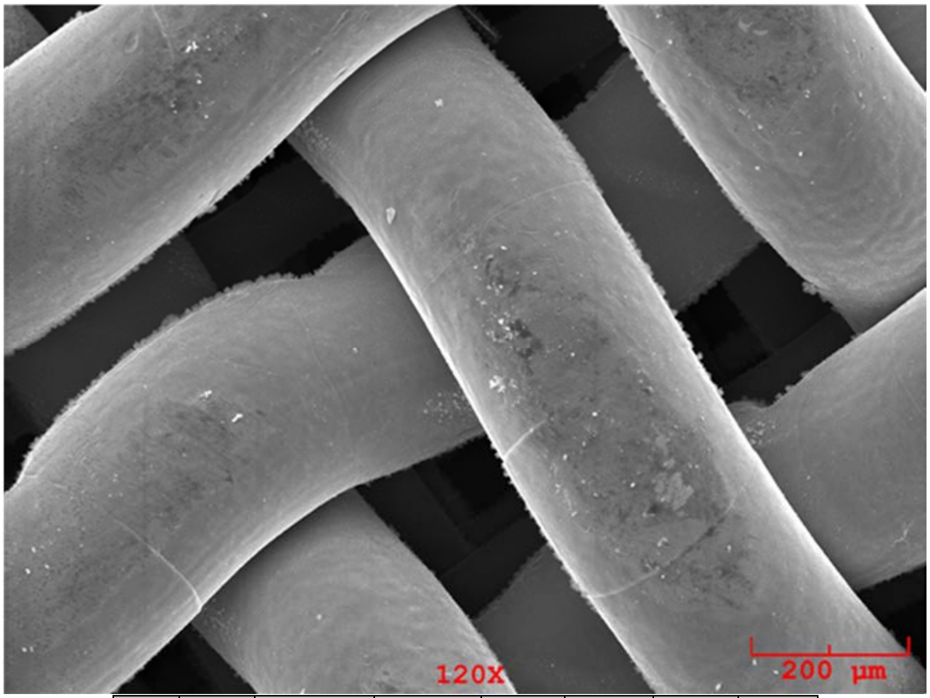


Figure R - 11 TMS Screen, Top, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	4.68	3.947	wt.%	0.566	0.663	
O	Ka	4.52	1.402	wt.%	0.199	0.227	
Al	Ka	2.45	0.516	wt.%	0.153	0.211	
Si	Ka	3.05	0.517	wt.%	0.131	0.179	
S	Ka	7.83	1.045	wt.%	0.122	0.148	
Cr	Ka	89.71	16.883	wt.%	0.379	0.198	
Mn	Ka	6.17	1.572	wt.%	0.216	0.269	
Fe	Ka	207.13	63.427	wt.%	0.904	0.308	
Ni	Ka	18.76	8.565	wt.%	0.475	0.402	
Cu	Ka	3.77	2.127	wt.%	0.367	0.450	
			100.000	wt.%			Total

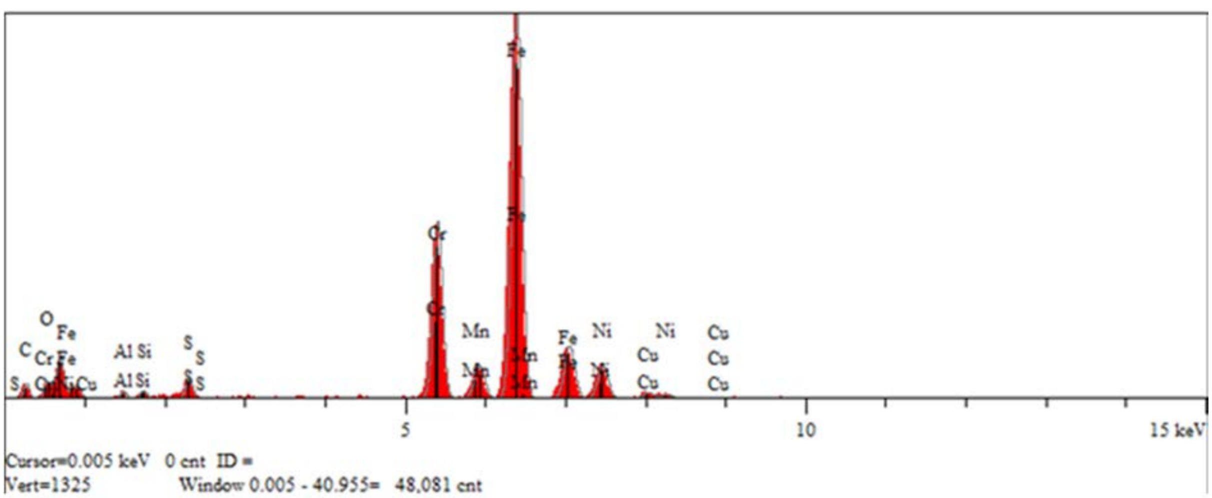


Figure R - 12 TMS Screen Top, 120X and EDX Elemental Analysis

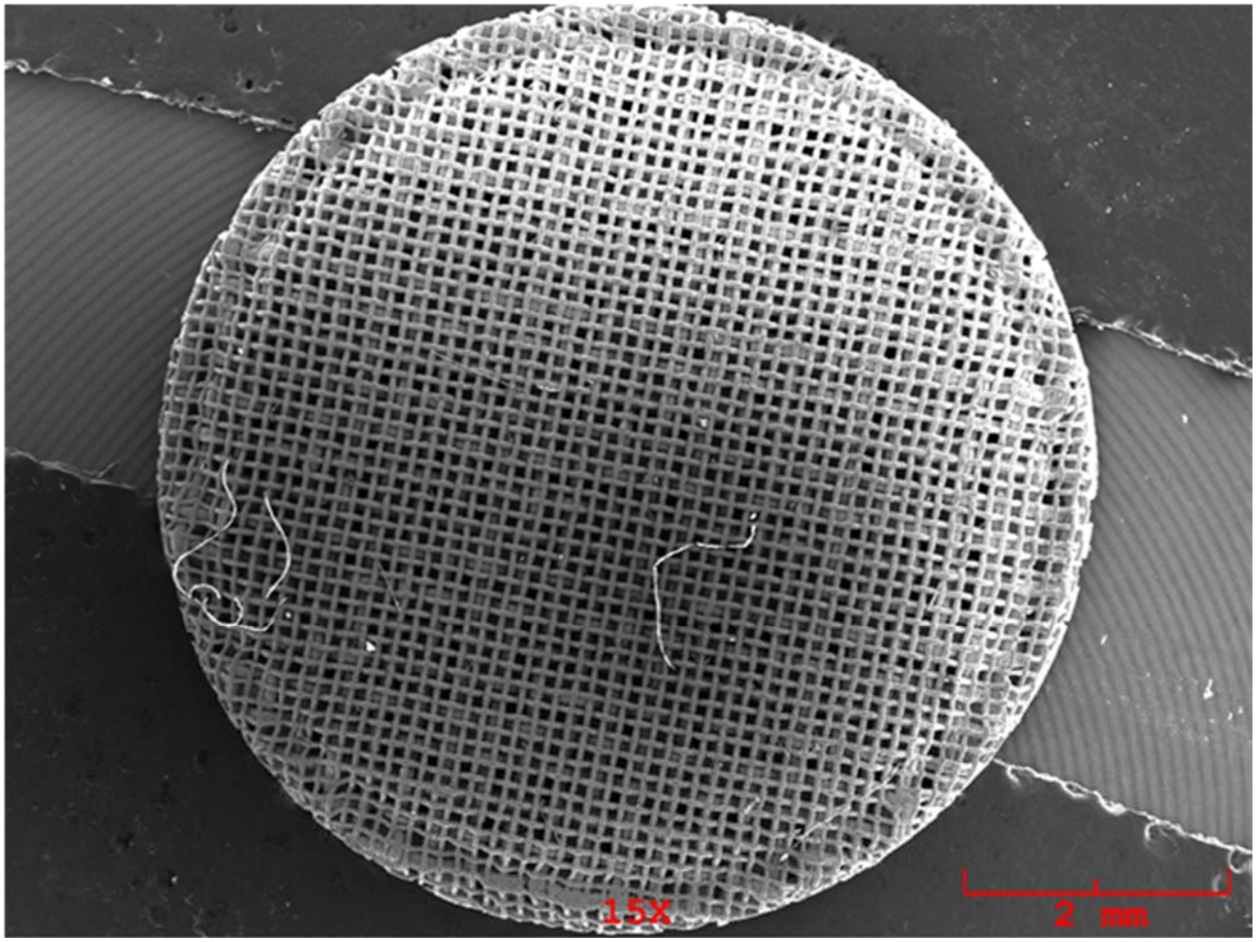
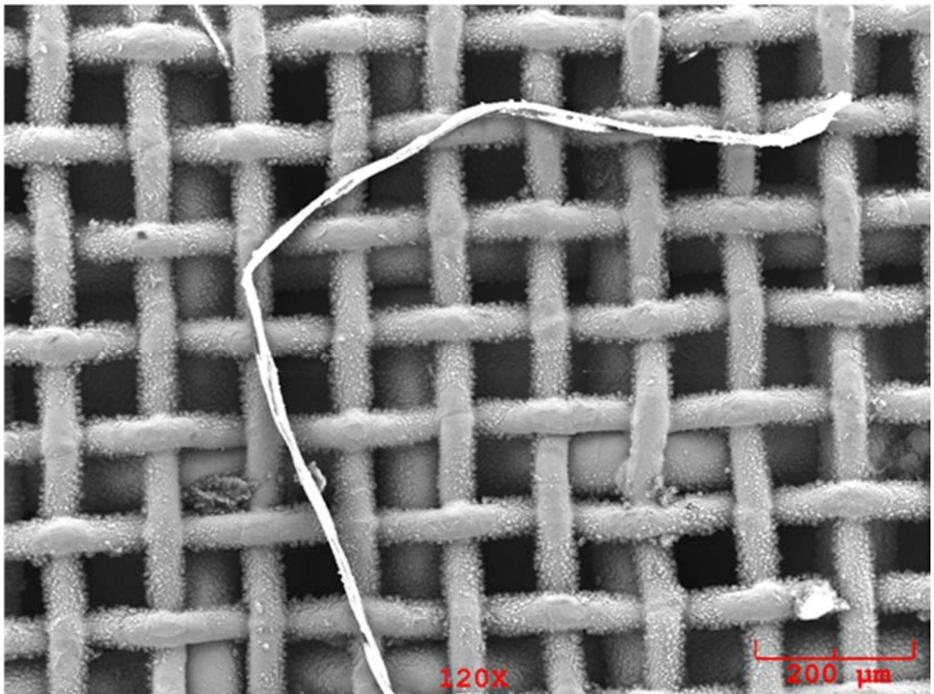


Figure R - 13 TMS Screen, Bottom, 15X Magnification



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	28.26	13.793	wt.%	0.663	0.632	
Al	Ka	8.74	0.963	wt.%	0.116	0.147	
Si	Ka	5.96	0.537	wt.%	0.096	0.131	
S	Ka	48.64	3.526	wt.%	0.126	0.115	
V	Ka	1.34	0.135	wt.%	0.101	0.150	
Cr	Ka	141.31	15.252	wt.%	0.277	0.158	
Mn	Ka	9.15	1.313	wt.%	0.165	0.214	
Fe	Ka	312.55	53.603	wt.%	0.628	0.250	
Ni	Ka	21.43	5.419	wt.%	0.312	0.316	
Cu	Ka	17.39	5.458	wt.%	0.355	0.366	
			100.000	wt.%			Total

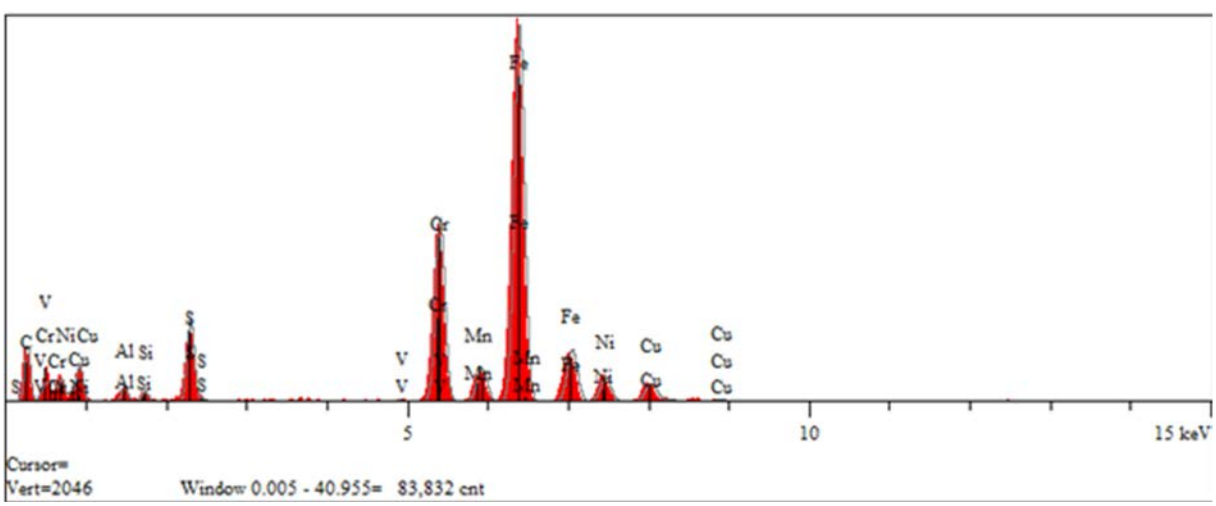


Figure R- 14 TMS Screen, Bottom, 120X and EDX Elemental Analysis

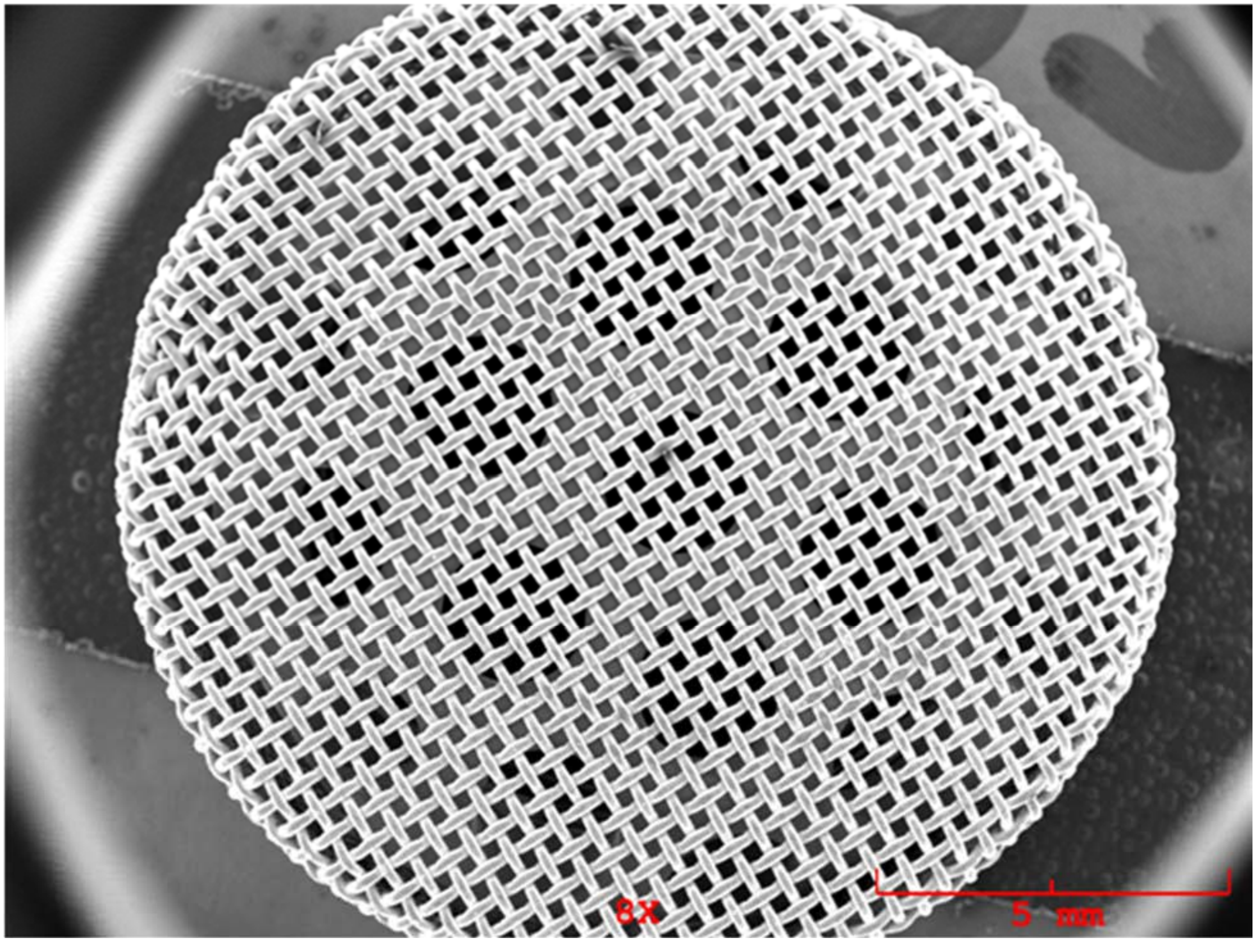
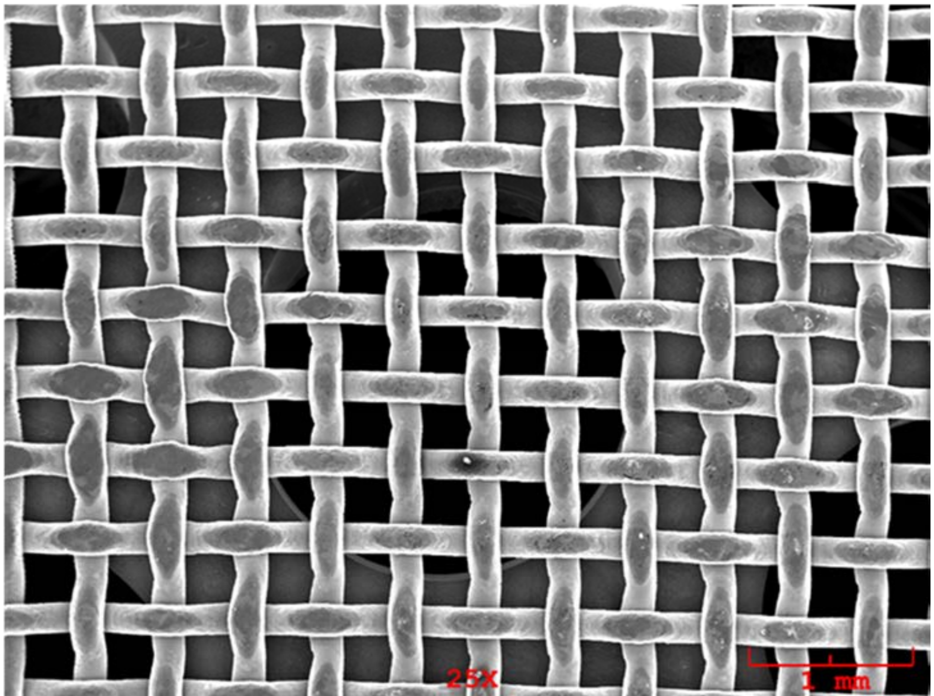


Figure R - 15 F303 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	6.36	3.481	wt.%	0.439	0.523	
O	Ka	1.52	0.302	wt.%	0.121	0.169	
Al	Ka	0.77	0.105	wt.%	0.112	0.168	
Si	Ka	4.89	0.531	wt.%	0.105	0.143	
S	Ka	15.80	1.354	wt.%	0.105	0.122	
Cr	Ka	138.17	16.555	wt.%	0.301	0.162	
Mn	Ka	10.09	1.649	wt.%	0.178	0.221	
Fe	Ka	339.44	66.844	wt.%	0.745	0.256	
Ni	Ka	31.16	9.178	wt.%	0.396	0.338	
			100.000	wt.%			Total

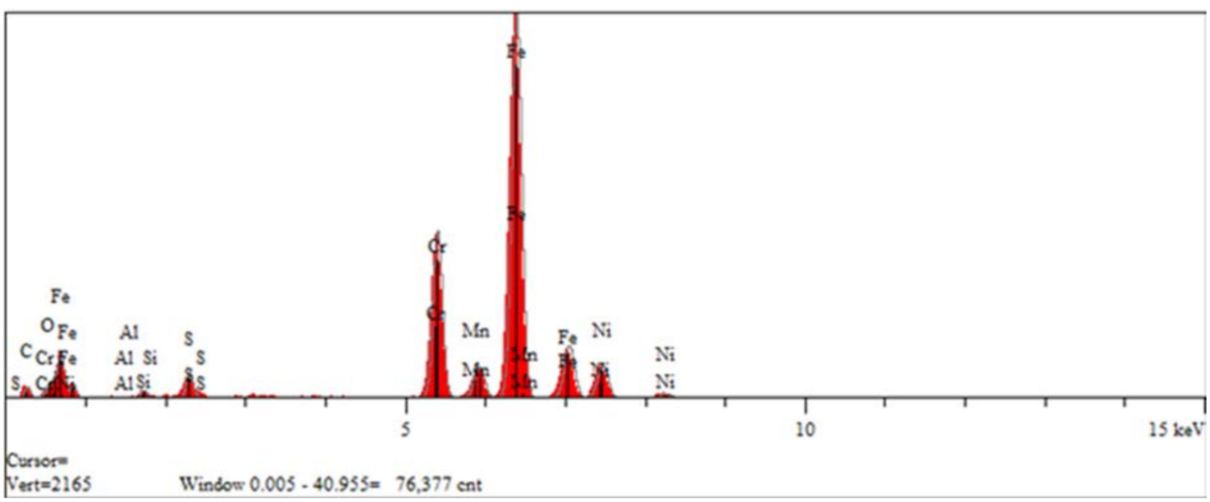


Figure R - 16 F303 Bottom 25X and EDX Elemental Analysis

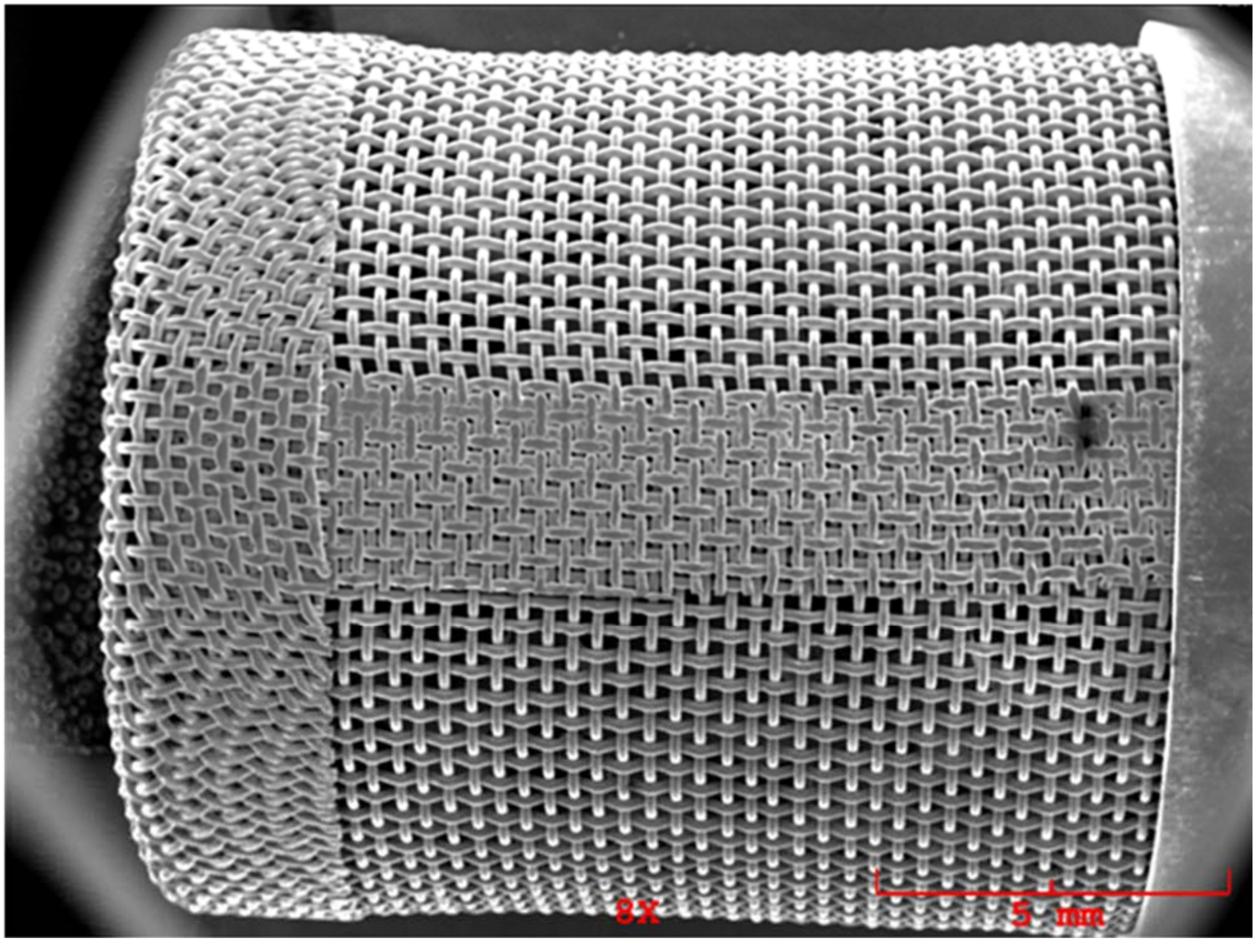
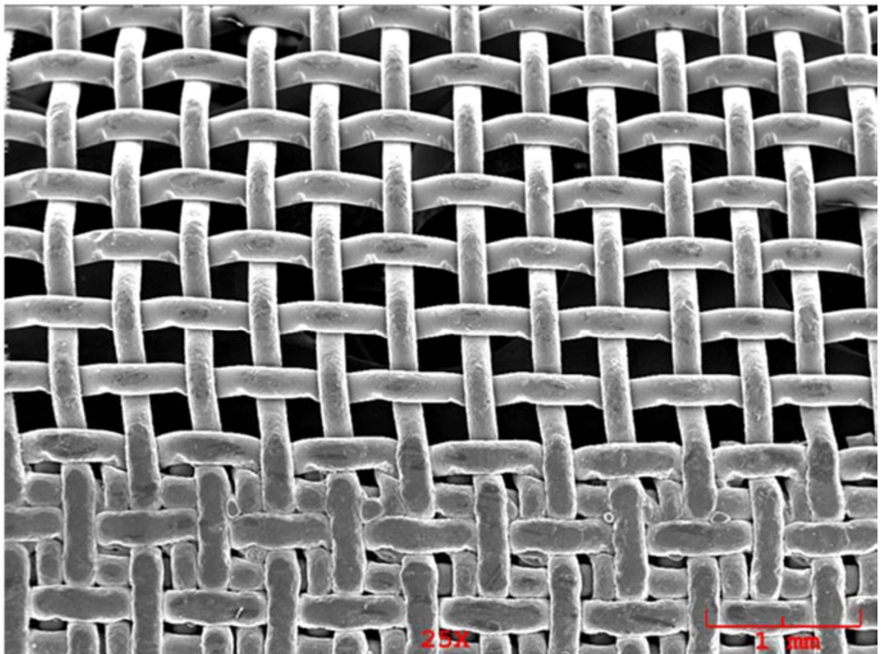


Figure R - 17 F303 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	5.72	2.571	wt.%	0.383	0.484	
O	Ka	1.96	0.313	wt.%	0.108	0.151	
Al	Ka	1.55	0.172	wt.%	0.106	0.157	
Si	Ka	6.31	0.562	wt.%	0.098	0.133	
S	Ka	18.53	1.299	wt.%	0.096	0.114	
Cr	Ka	169.49	16.521	wt.%	0.272	0.149	
Mn	Ka	12.13	1.615	wt.%	0.161	0.201	
Fe	Ka	420.64	67.453	wt.%	0.675	0.233	
Ni	Ka	39.54	9.494	wt.%	0.358	0.295	
			100.000	wt.%			Total

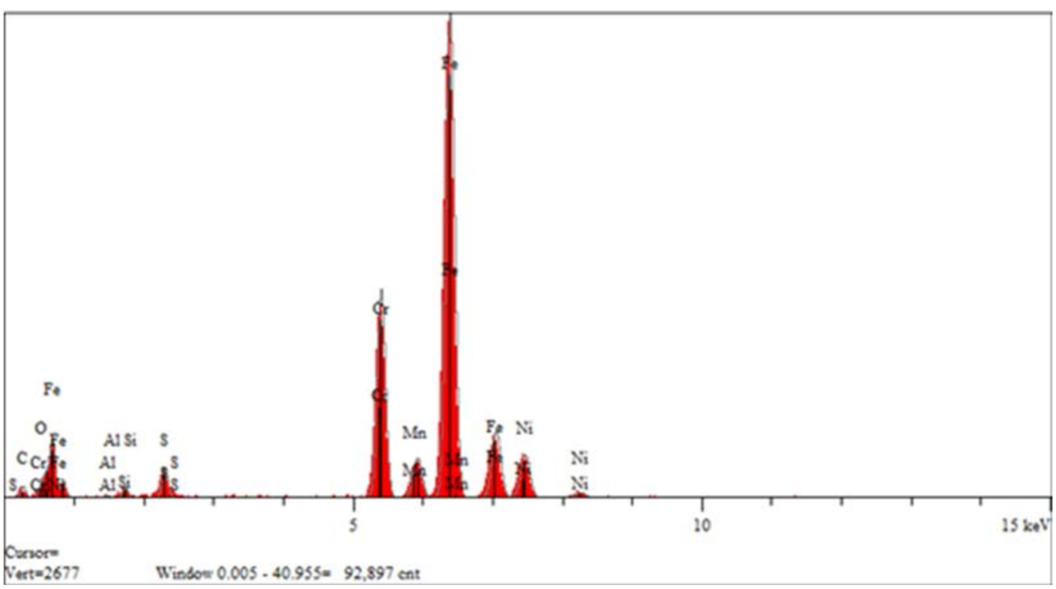


Figure R - 18 F303 Side 25X and EDX Elemental Analysis

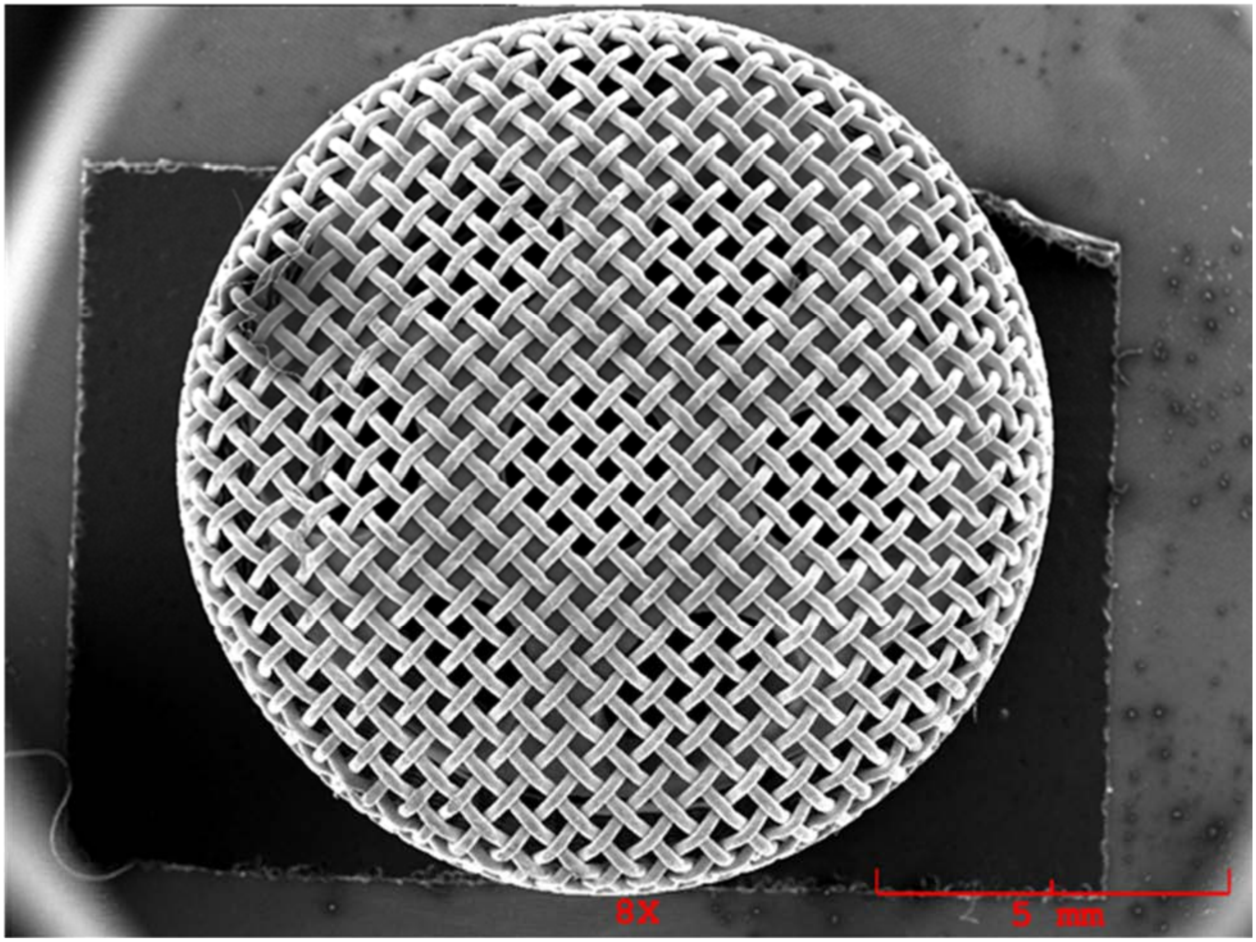
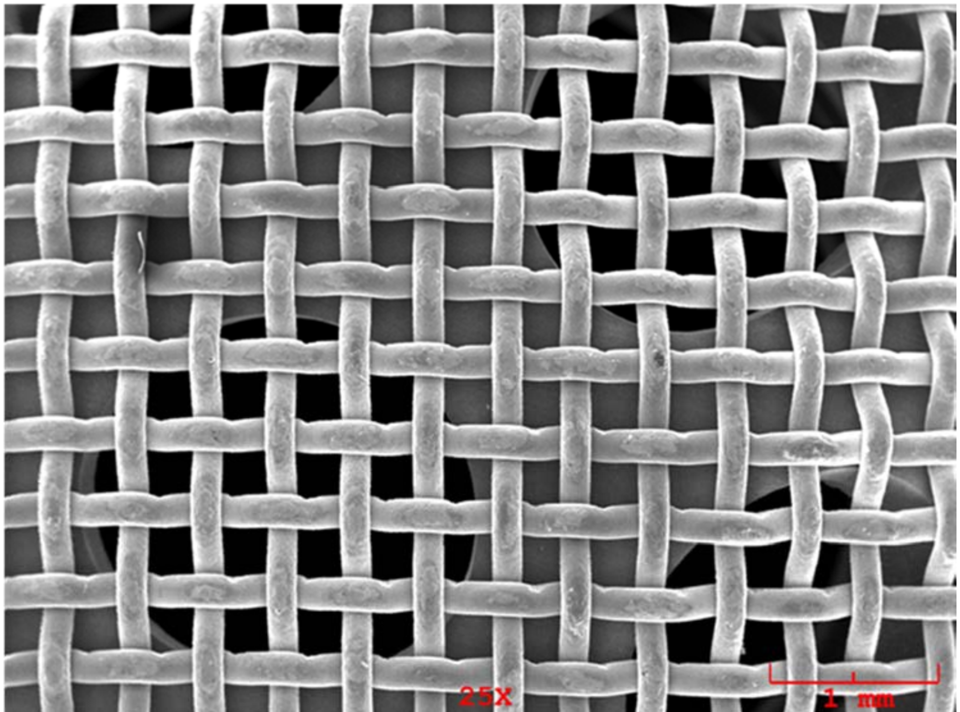


Figure R - 19 F304 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	8.68	4.932	wt.%	0.508	0.586	
O	Ka	4.16	0.887	wt.%	0.147	0.182	
Al	Ka	1.50	0.210	wt.%	0.119	0.175	
Si	Ka	4.01	0.453	wt.%	0.108	0.150	
S	Ka	17.09	1.523	wt.%	0.112	0.129	
Cr	Ka	126.00	15.758	wt.%	0.301	0.166	
Mn	Ka	8.68	1.486	wt.%	0.183	0.233	
Fe	Ka	320.15	65.926	wt.%	0.759	0.281	
Ni	Ka	28.66	8.824	wt.%	0.400	0.347	
			100.000	wt.%			Total

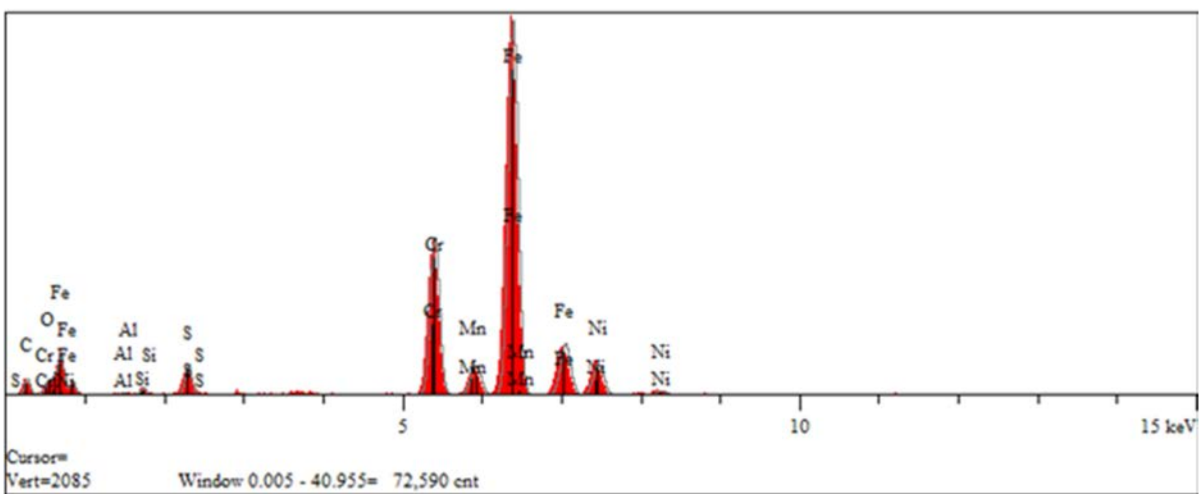


Figure R - 20 F304 Bottom, 25X and EDX Elemental Analysis

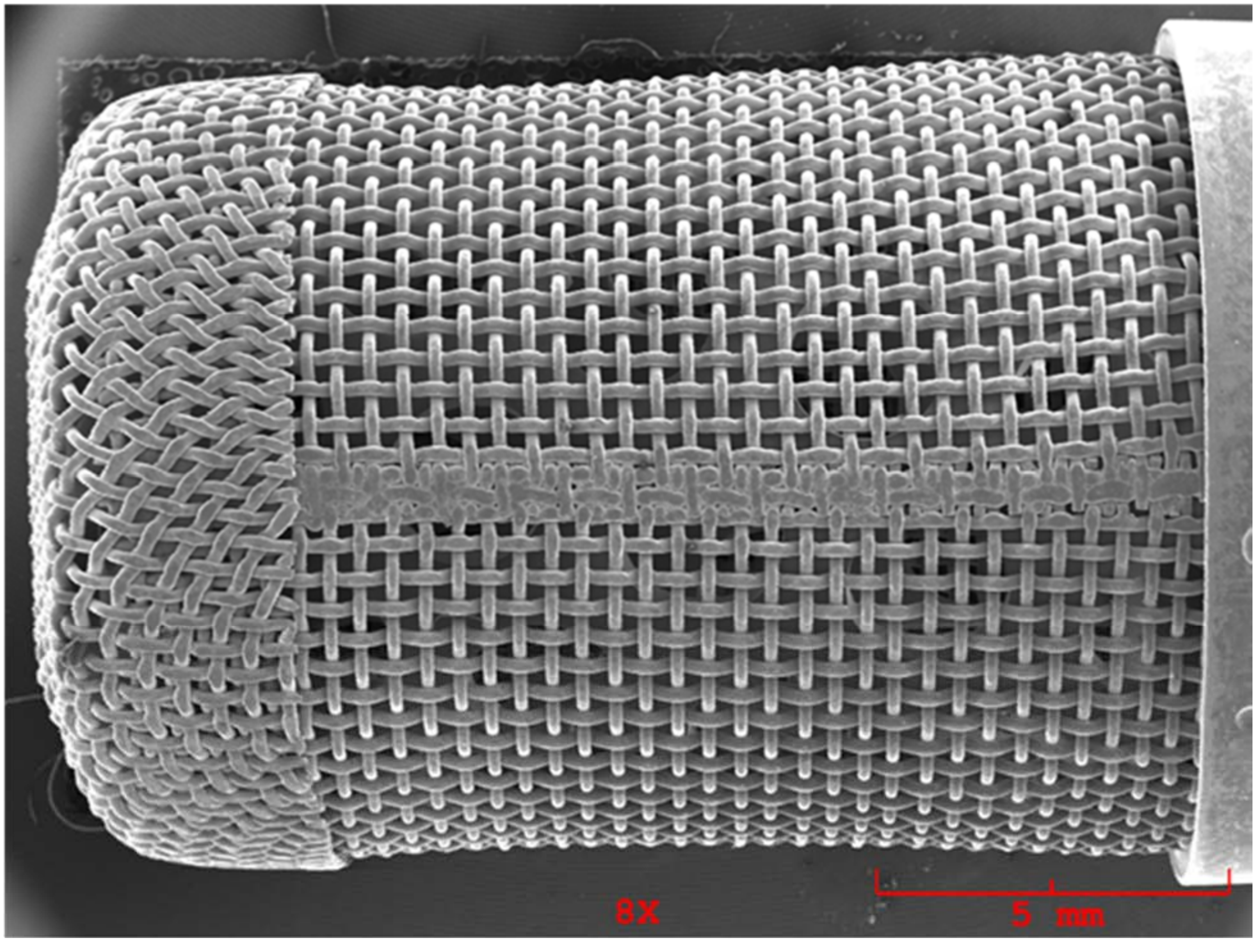
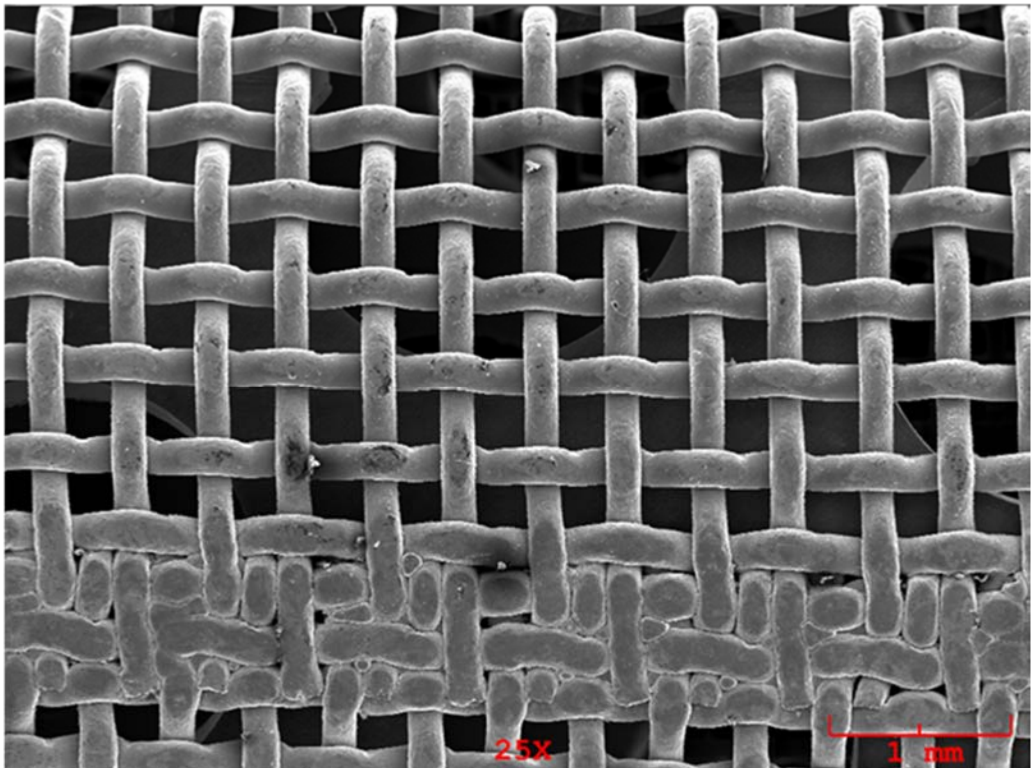


Figure R - 21 F304 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	9.14	4.478	wt.%	0.454	0.527	
O	Ka	5.57	1.008	wt.%	0.144	0.178	
Al	Ka	1.16	0.139	wt.%	0.107	0.159	
Si	Ka	5.98	0.577	wt.%	0.101	0.137	
S	Ka	21.81	1.662	wt.%	0.105	0.119	
Cr	Ka	146.72	15.664	wt.%	0.278	0.154	
Mn	Ka	10.13	1.479	wt.%	0.166	0.210	
Fe	Ka	375.00	65.848	wt.%	0.699	0.250	
Ni	Ka	34.82	9.145	wt.%	0.375	0.323	
			100.000	wt.%			Total

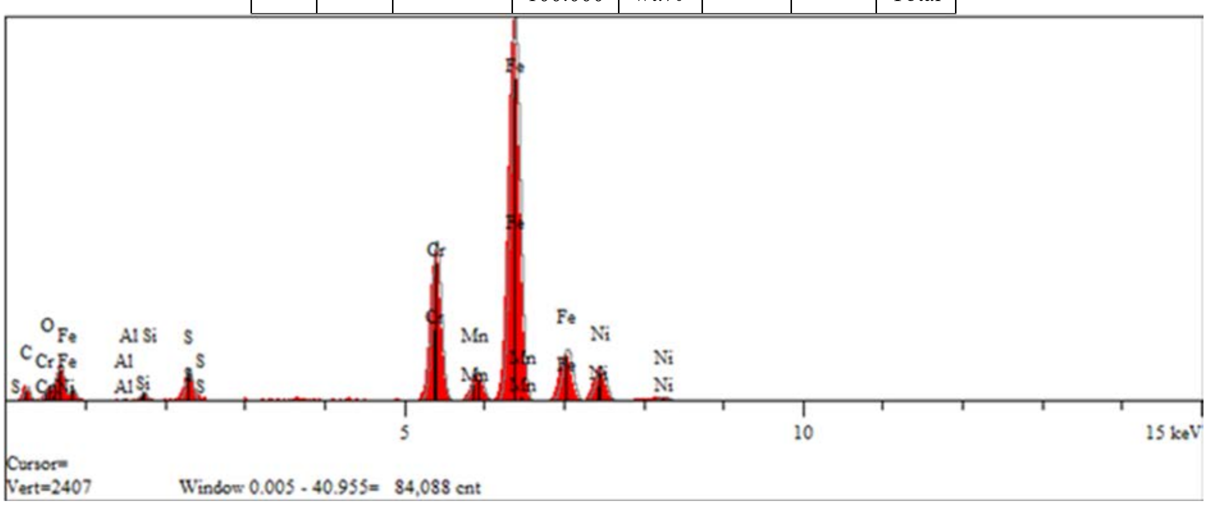


Figure R - 22 F304 Side, 25X and EDX Elemental Analysis

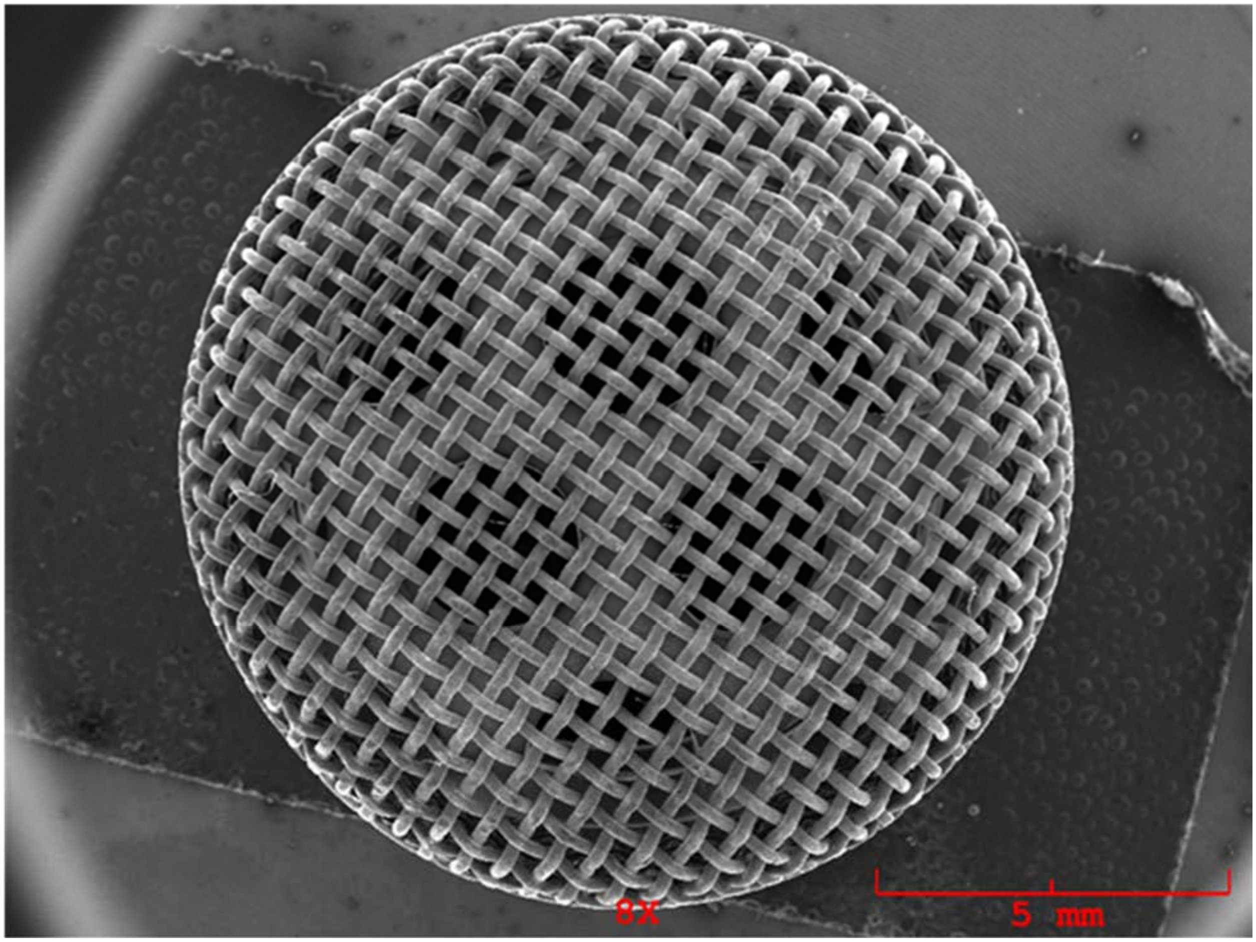
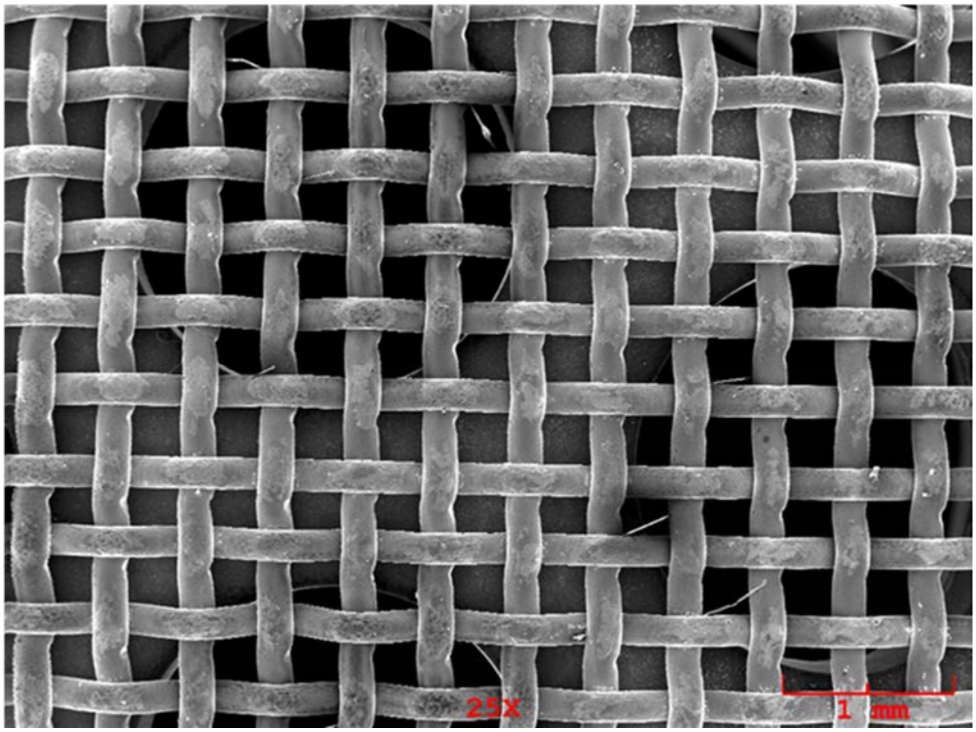


Figure R - 23 F702 Bottom, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	17.52	20.781	wt.%	1.138	0.850	
O	Ka	2.87	1.814	wt.%	0.309	0.341	
Al	Ka	0.85	0.237	wt.%	0.163	0.236	
Si	Ka	2.14	0.489	wt.%	0.148	0.202	
S	Ka	18.58	3.477	wt.%	0.200	0.180	
Cr	Ka	44.79	12.755	wt.%	0.412	0.239	
Mn	Ka	3.98	1.525	wt.%	0.250	0.303	
Fe	Ka	112.55	51.425	wt.%	0.997	0.358	
Ni	Ka	11.12	7.497	wt.%	0.516	0.387	
			100.000	wt.%			Total

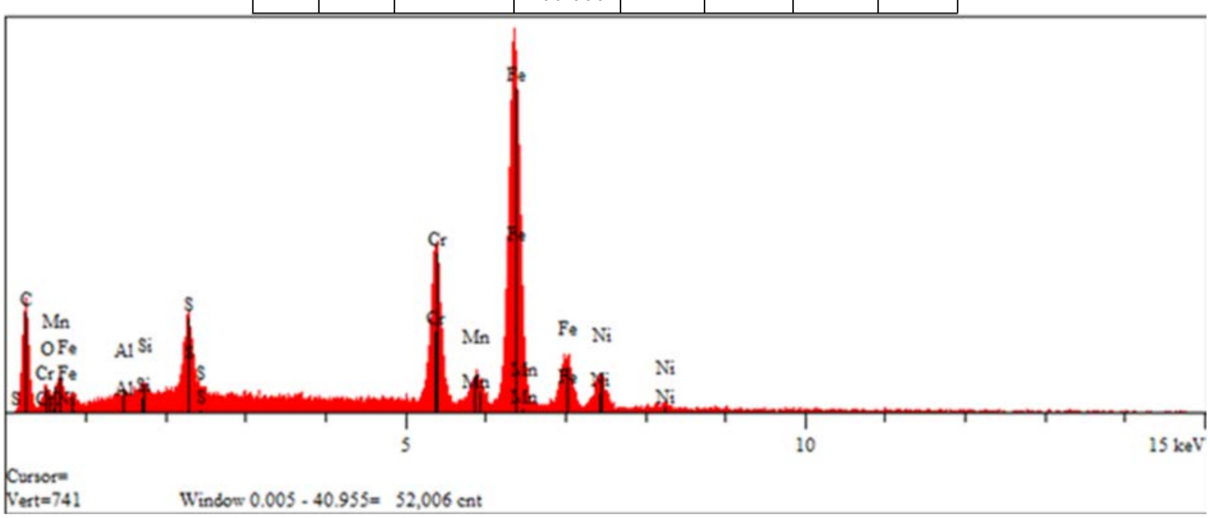


Figure R - 24 F702 Bottom, 25X and EDX Elemental Analysis

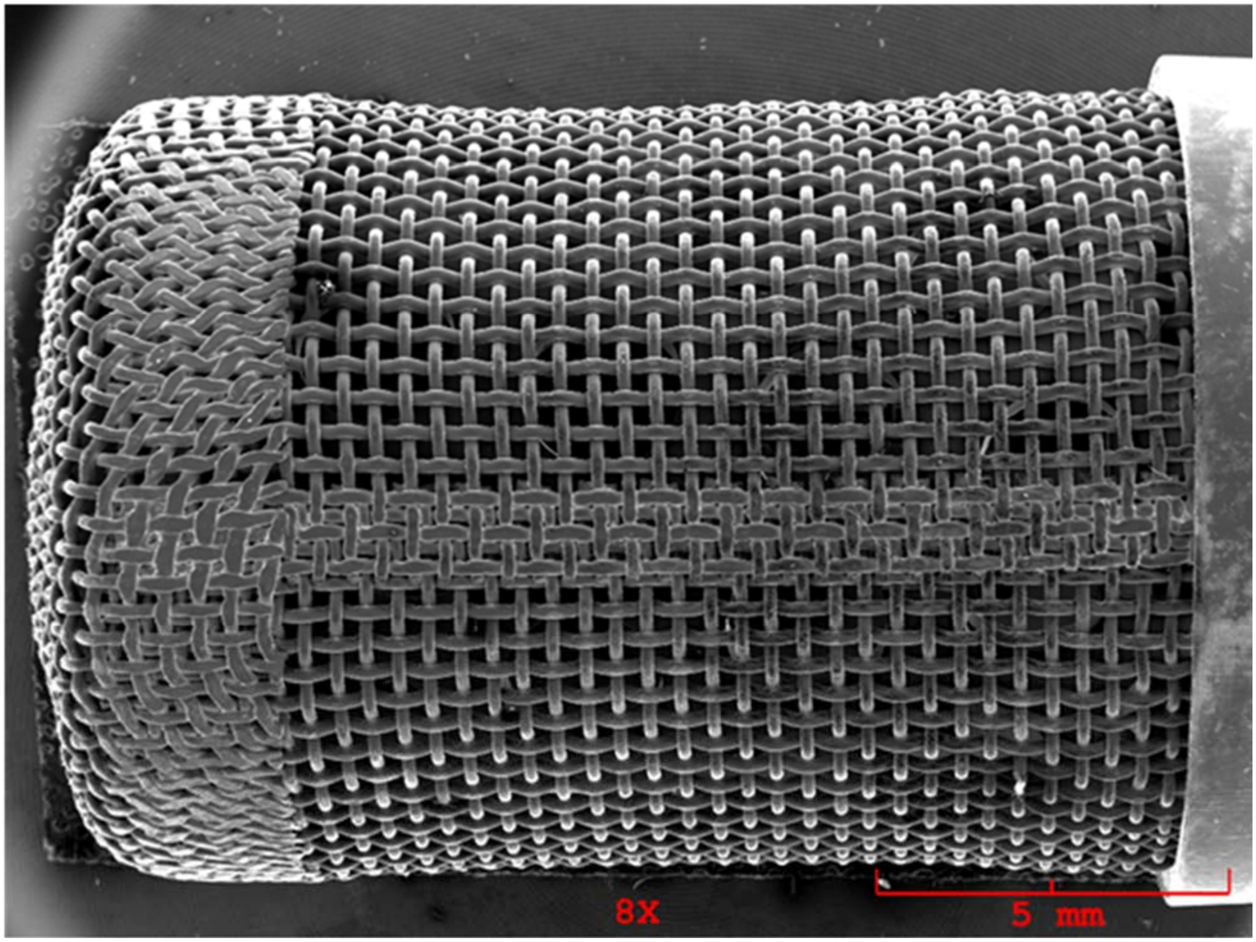
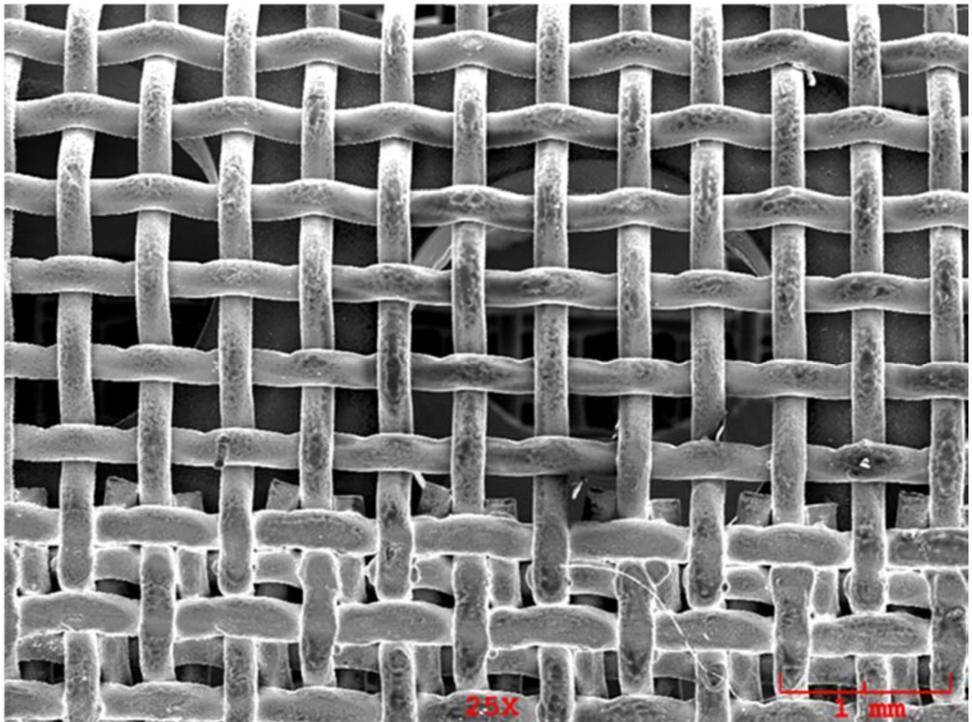


Figure R - 25 F702 Side, 8X



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	53.21	25.303	wt.%	0.767	0.500	
O	Ka	8.78	2.437	wt.%	0.230	0.246	
Al	Ka	2.29	0.248	wt.%	0.097	0.140	
Si	Ka	4.80	0.428	wt.%	0.088	0.121	
S	Ka	60.86	4.501	wt.%	0.135	0.108	
Cr	Ka	103.15	11.938	wt.%	0.254	0.149	
Mn	Ka	7.67	1.187	wt.%	0.155	0.197	
Fe	Ka	257.89	47.571	wt.%	0.611	0.229	
Ni	Ka	23.60	6.388	wt.%	0.328	0.299	
			100.000	wt.%			Total

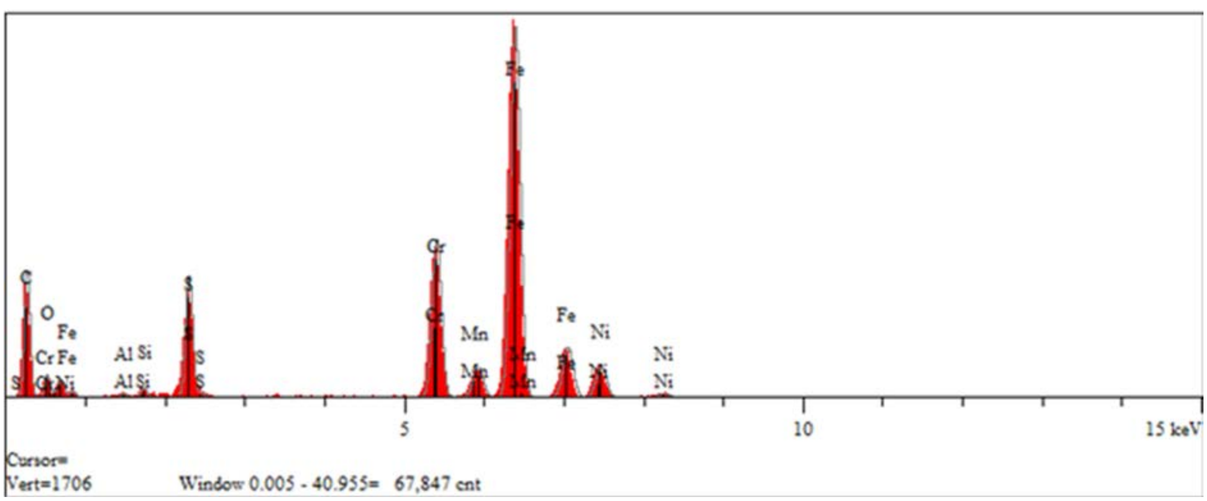


Figure R -26 F702 Side, 25X and EDX Elemental Analysis